9.0 ENGINEERING COSTS

This chapter presents the costs estimated for compliance with the effluent limitations guidelines and standards for the Landfills industry. Section 9.1 provides a discussion of the cost-estimation methodologies considered by EPA including evaluation of two cost-estimation models. Section 9.2 presents a discussion of the types of cost estimates developed, while in Section 9.3, the development of capital costs, operating and maintenance (O&M) costs, and other related costs is described in detail. Section 9.4 summarizes the compliance costs for each regulatory option considered by EPA.

9.1 Evaluation of Cost-Estimation Techniques

This section presents a discussion of the cost-estimation techniques considered by EPA, including evaluation of two cost-estimation models. In this section, the Agency presents the criteria used to evaluate these techniques as well as the results of a benchmark analysis to compare the accuracy of these techniques. This section also presents the selected cost-estimation techniques.

9.1.1 Cost Models

EPA developed compliance-cost estimates for leachate treatment systems to determine the economic impact of the regulation. EPA has identified existing cost-estimation models to facilitate the development of compliance-cost estimates. In a mathematical cost model, various design and vendor data on a variety of treatment technologies are combined and cost equations that describe costs as a function of system parameters, such as flow, are developed for each treatment technology. Using these types of models allows for the generation of compliance-cost estimates for several regulatory options that are based on the iterative addition of treatment technologies and can assist EPA in the selection of options as the basis for the regulations.

EPA evaluated the following two well-known cost models for use in developing costs:

- Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET), developed by the U.S. Army Corps of Engineers.

- W/W Costs Program (WWC), Version 2.0, developed by CWC Engineering Software.

CAPDET is intended to provide planning level cost estimates to analyze alternatives in the design of wastewater treatment systems. Modules are used to develop cost estimates for a variety of physical, chemical, and biological treatment unit processes and can be linked together to represent entire treatment trains. Equations in each of these modules are based upon common engineering principles used for wastewater treatment system design. The CAPDET algorithm generates a design based on input parameters selected by the user, calculates cost estimates for various treatment trains, and ranks them based on present worth, capital, operating, or energy costs.

The WWC cost model was developed by Culp/Wesner/Culp from a variety of engineering sources, including vendor supplied data, actual plant construction data, unit takeoffs from actual and conceptual designs, and published data. The model calculates cost estimates for a variety of individual treatment technology units that can be combined together to develop compliance-cost estimates for the complete treatment systems. The WWC model does not design each treatment technology unit but rather prompts the user to provide design-input parameters that form the basis for the cost estimate. The WWC model includes a separate spreadsheet program that provides design criteria guidelines to assist in developing the input parameters to the cost-estimating program. The spreadsheet includes treatment component design equations and is supplied with default parameters that are based upon accepted design criteria used in wastewater treatment, to assist in the design of particular treatment units. The spreadsheet also is flexible enough to allow selected design parameters to be modified to estimate industry-specific factors accurately. Once design inputs are entered into the program, the WWC model calculates both construction and operation and maintenance (O&M) costs for the selected wastewater treatment system.

9.1.2 Vendor Data

For certain wastewater treatment technology units, the cost model was not considered the most accurate

estimate of costs. For these instances, EPA determined that reported equipment and operation and maintenance costs obtained directly from equipment vendors often can provide accurate cost estimates.

EPA provided information on landfill wastewater characteristics to vendors to determine the appropriate treatment unit and accurate sizing. Quotes obtained from vendors included equipment costs that EPA factored up to total capital costs to account for site preparation, mobilization costs, and engineering contingencies. EPA also obtained vendor quotes for operation and maintenance costs, including utility usage and cost. The Agency used vendor quotes to determine cost curves for equalization, multi-media filtration, granular activated carbon, breakpoint chlorination, and reverse osmosis. EPA based the cost curves used for these treatment technologies on direct vendor quotes, commercial costing guides, or cost information developed from vendor quotes as part of the Centralized Waste Treatment (CWT) effluent guidelines effort.

9.1.3 Other EPA Effluent Guideline Studies

EPA reviewed other EPA effluent studies, such as the Organic Chemicals and Plastics and Synthetic Fibers (OCPSF) industry effluent guidelines, to obtain additional costing background and supportive information. However, EPA did not use costs developed as part of other industrial effluent guidelines in costing for this industry, with the exception of the CWT effluent guideline data referenced in Section 9.1.2.

9.1.4 Benchmark Analysis and Evaluation Criteria

EPA performed benchmark analyses to evaluate the accuracy of each cost-estimation technique. This benchmark analysis used reported costs provided in the 308 Questionnaires and compared them to costs generated using each cost-estimation technique. EPA selected four landfill facilities (Questionnaire Identification numbers (QIDs) 16122, 16125, 16041, and 16087) with wastewater treatment systems for the benchmark analysis. The agency developed cost estimates for wastewater treatment units that make up the treatment systems at these landfill facilities using the WWC and CAPDET models and vendor quotes. Next, EPA compared these cost estimates to the reported component costs provided in the 308 Questionnaires to evaluate the accuracy of each methodology in estimating capital and operation and

maintenance costs. This cost comparison is presented in Table 9-1. Treatment technologies that EPA used in this benchmark analysis include the following:

- equalization,
- chemical precipitation,
- activated sludge,
- sedimentation, and
- multi-media filtration.

EPA also benchmarked cost estimates developed using these techniques against reported costs for wastewater treatment systems that included equalization, chemical precipitation, and multimedia filtration and were obtained from industrial waste combustor facilities as part of that effluent guidelines effort. EPA believes that the wastewater characteristics being treated by these treatment systems, i.e., inorganic contaminants and solids in an uncomplexed matrix, are similar for both landfills and industrial waste combustor facilities and that this additional comparison provides a more thorough evaluation of the Agency's cost-estimation methodologies. Table 9-2 presents a comparison of the capital and O&M costs obtained for the wastewater treatment systems at four industrial waste combustor facilities to the cost estimates obtained using each technique, i.e., the WWC and CAPDET models, and vendor quotes.

As shown in Tables 9-1 and 9-2, EPA has determined that, based on the results of the benchmark analyses for both data sources, the WWC model generated cost estimates that are considered more accurate than the CAPDET model when compared to reported treatment technology costs as provided in 308 Questionnaire responses. In all instances, the WWC model estimated the more accurate treatment system capital and O&M costs as compared to CAPDET and vendor costs. For several facilities, such as QIDs 16087, 16122, and 16125, the WWC model generated capital costs to within 32 percent of costs provided in the questionnaires. EPA estimated O&M costs for several facilities, including QIDs 16041, 16087, and 16122, to within 18 percent of costs provided in the 308 Questionnaires.

EPA used the following criteria to evaluate each cost-estimation technique and to select the appropriate option for developing a methodology for estimating compliance costs for the Landfills industry:

- Does the model contain costing modules representative of the various wastewater technologies in use or planned for use in the Landfills industry?
- Can the model produce costs in the expected flow range experienced in this industry?
- Can the model be adapted to cost entire treatment trains used in the Landfills industry?
- Is sufficient documentation available regarding the assumptions and sources of data so that costs are credible and defensible?
- Is the model capable of providing detailed capital and operation and maintenance costs with unit-costing breakdowns?
- Is the model capable of altering the default design criteria in order to accurately represent reported design criteria indicative of the Landfills industry?

9.1.5 Selection of Final Cost-Estimation Techniques

Based upon the results of the benchmark analysis, EPA selected the WWC model for estimating costs for the majority of the treatment technologies that form the basis for BPT/BAT/NSPS effluent limitations and standards. The Agency determined that the WWC model is capable of producing accurate capital and O&M costs for a wide range of treatment technologies. EPA found that the CAPDET model was not capable of generating cost estimates for many of the technologies that form the basis for BPT/BAT/NSPS effluent limitations and standards for the Landfills industry, and the Agency determined that it was not accurate in estimating technology costs for landfill facilities. Therefore, EPA decided not to use the CAPDET model for estimating compliance costs.

EPA has determined that the WWC model best satisfies the selection criteria. The program can estimate costs for a wide range of typical and innovative treatment technologies and can combine these costs of each technology to develop system costs. Since the WWC model is a computer based program, it readily allows for the iterative development of costs for a number of facilities and regulatory options. The program utilizes cost modules that can accommodate the range of flows and design-input parameters needed to develop cost estimates for landfill facilities. Cost estimates generated by this model are based upon a

number of sources, including actual construction and operation costs, along with published data, and are presented in a breakdown summary table that contains unit costs and totals. Finally, the WWC model can be adapted to estimate costs based upon specified design criteria and wastewater flow rates.

EPA notes that there were particular technologies for which the WWC model did not produce accurate cost estimates. These technologies included equalization, multimedia filtration, granular activated carbon, breakpoint chlorination, and reverse osmosis. In some low-flow situations, costs developed for these treatment technologies were excessively high as compared to industry provided costs in 308 Questionnaire responses. For these technologies, EPA determined that vendor quotes provided a more accurate estimate of compliance costs and would be used in the final engineering costing methodology for these technologies.

In addition, in a select few cases, EPA determined that it would be more economically feasible for some facilities to truck/pipe their wastewater off-site for treatment than to construct and maintain their own wastewater treatment system. These facilities had extremely low average daily flow rates (50 gallons or less); therefore, EPA substituted an off-site disposal cost for CWT treatment for BPT/BAT capital and O & M costs (see also 9.2.6).

9.2 Engineering Costing Methodology

This section presents the costing methodology used to develop treatment costs for BPT, BCT, and BAT options for the Landfills industry. This section also presents a description of additional costs, such as monitoring costs, that EPA developed. The following discussion presents a detailed summary of the technical approach used to estimate the compliance costs for each landfill facility. The Agency developed total capital and annual operation and maintenance costs for each facility in its database to upgrade its existing wastewater treatment system, or to install new treatment technologies, to comply with the long term averages for each regulatory option. Development of the long-term averages is discussed in Chapter 11 of this document and in the Statistical Support documents. EPA costed facilities primarily using the WWC model and, on occasion, from cost curves developed from vendor quotes. Table 9-3 presents a breakdown

of the cost-estimation method used for each treatment technology. EPA developed additional costs for monitoring, Resource Conservation and Recovery Act (RCRA) permit modifications, and residual disposal. The Agency developed total facility compliance costs under each BPT, BCT, and BAT option by adding treatment costs with these additional costs. EPA did not develop cost estimates for zero or alternative discharge facilities for any of the regulatory options (with the exception of some low flow facilities, see 9.2.5).

9.2.1 Treatment Costing Methodology

The methodology used to develop facility-specific BPT, BCT, and BAT option-compliance costs is presented graphically on the flow diagram in Figure 9-1. EPA costed facilities for an entire new treatment system, whether or not they had existing treatment at the facility, if the collected flow subject to this guideline was less than 85 percent of the total facility flow rate.

For each regulatory option, EPA evaluated each landfill facility in the Detailed Questionnaire database to determine if the facility would incur costs in order to comply with the regulations. EPA compared the current discharge concentrations of the facility's effluent with the long-term averages from each regulatory option. If the facility's current discharge concentration was less than the long-term average, EPA considered it to be in compliance. A facility considered to be in compliance was projected to incur costs only for additional monitoring requirements. If a facility was not in compliance but had treatment unit operations in-place capable of complying with the long-term averages, EPA costed the facility for system upgrades that would bring the facility into compliance.

For facilities that did not have BPT/BCT/BAT treatment systems or the equivalent, the Agency developed cost estimates for the additional unit operations and/or system upgrades necessary to meet each long term average. Facilities that were already close to compliance with the long-term averages only required an upgrade to achieve compliance with limitations for a regulatory option. EPA developed upgrade costs using the WWC model whenever possible and included either additional equipment to be installed as part

of an existing wastewater treatment system, expansion of existing equipment, or operational changes. Examples of upgrade costs include such items as new or expanded chemical feed systems and improved or expanded aeration systems. If a facility had no treatment system (or one that could not achieve desired levels with upgrades or minor additions) the Agency developed cost estimates for an entire BPT/BCT/BAT treatment system for that facility.

The first step in using the WWC model was to use the design-criteria guidelines spreadsheet to develop input parameters for the computer program. EPA used reported pollutant loadings from the facility whenever possible. If pollutant loadings were not available for a particular parameter, EPA used the estimates of pollutant concentrations in untreated landfill wastewater (see Chapter 6). The Agency also used the facility's baseline flow rate and the regulatory option long-term averages in the design of the unit operation. Certain parameters such as BOD_5, TSS, and ammonia are used directly in the WWC model and the design-criteria guideline spreadsheet to design the various treatment unit operations. EPA selected metals that were included as pollutants of interest to assist in the design of chemical precipitation systems. The metals to be treated typically control the type and amount of precipitating agents, which govern the chemical feed system design. A more detailed discussion of the design parameters and costs associated with individual treatment technologies is presented in Section 9.3.

The design parameters from the design-criteria spreadsheet then were input in the WWC model to generate installed capital and O&M costs. O&M costs for treatment chemicals, labor, materials, electricity, and fuel are included in the WWC model O&M costs. Treatment costs developed using the WWC model were corrected to 1992 dollars using the Engineering News Record published indexes. After EPA developed the installed capital and annual O&M costs for each facility, it applied selected cost factors, as shown in Table 9-4, to the results to develop total capital and O&M costs.

To complete the estimation of compliance costs for each regulatory option, EPA developed cost estimates for other than treatment component costs. The assessment must take into account other costs associated

with compliance with the effluent limitations guidelines and standards, including the following:

- land,
- residual disposal,
- RCRA permit modifications, and
- monitoring.

Each of these additional costs are further discussed and defined in the following sections.

The Agency developed final capital costs for each facility and then amortized them using a seven percent interest rate over 15 years. EPA the added this annualized capital cost to the annual O&M cost to develop a total annual cost for each regulatory option.

9.2.1.1 Retrofit Costs

EPA applied a retrofit cost factor when additional equipment or processes were required for existing systems. Retrofit costs cover the need for system modifications and components, such as piping, valves, controls, etc., that are necessary to connect new treatment units and processes to an existing treatment facility. EPA estimated retrofit costs at 20 percent of the installed capital cost of the equipment.

9.2.2 Land Costs

EPA did not include land costs in this analysis because it determined that landfills have adequate land to accommodate additional treatment systems. Typically, the size of the required treatment system is small when compared to the land area occupied by landfills. Landfills, as required by regulation and permit, have buffer zones around the fill areas. New treatment systems, or upgrades to an existing system, can be installed readily in this buffer zone or elsewhere at the landfill without the need to acquire new land.

9.2.3 Residual Disposal Costs

For each of the proposed treatment system additions or upgrades, EPA estimated a cost for residual disposal. The Agency used two approaches: the first addressed facilities with current sludge-handling

capabilities, while the second addressed facilities without current sludge handling capabilities. EPA prepared residual disposal costs on an annualized basis and added to the total O&M costs.

For facilities with sludge-handling capabilities, EPA evaluated the present solids treatment/dewatering system to determine if it was capable of handling the additional sludge expected to be produced under a particular regulatory option. For facilities with insufficient capacity to handle the additional solids loadings, EPA developed upgrade costs for sludge conditioning and dewatering to account for the additional solids. For facilities with sufficient solids treatment capability, the Agency did not provide additional sludge-treatment costs. For facilities without installed sludge conditioning and dewatering facilities, EPA developed cost estimates for a sludge conditioning and dewatering systems.

Dewatered sludge is assumed to be disposed of on-site in the landfill. EPA's cost estimate also includes the costs associated with the handling and transportation of the sludge to the on-site landfill.

9.2.4 Monitoring Costs

EPA developed costs for the monitoring of treatment system effluent for direct dischargers. The Agency based the costs upon the following assumptions:

- Monitoring costs are based on the number of outfalls through which leachate/ground water is discharged. The costs associated with a single outfall is multiplied by the total number of outfalls to arrive at the total cost for a facility. Monitoring costs estimated by EPA are incremental to the costs already incurred by the facility.
- The capital costs for flow-monitoring equipment are included in EPA's estimates.
- Sample-collection costs (equipment and labor) and sample shipment costs are not included in EPA's estimates because EPA assumes that the facility is already conducting these activities as part of its current permit requirements.

Based upon a review of current monitoring practices at landfills, many conventional and nonconventional parameters, as well as several metals, are already being monitored on a routine basis. EPA developed monitoring costs based upon BOD_5 and TSS monitoring 20 times per month and weekly monitoring of ammonia and other toxic and nonconventional pollutants. In general, these frequencies are higher than currently required. Table 9-5 presents the monitoring cost per sample for the landfill facilities.

9.2.5 Off-Site Disposal Costs

EPA evaluated whether it would be more cost effective for small-flow facilities to have their landfill wastewater hauled off site and treated at a centralized waste treatment facility, as opposed to on-site treatment. EPA compared total annual costs for new or upgraded wastewater treatment facilities to the costs for off-site treatment at a centralized waste treatment facility. Off-site disposal costs were estimated at $0.25 per gallon of wastewater treated. EPA added transportation costs to the off-site treatment costs at a rate of $3.00 per loaded mile using an average distance of 250 miles to the treatment facility. The Agency based transportation costs upon the use of a 5,000-gallon tanker truck load. Facilities that treat their wastewater off site are considered zero or alternative dischargers and, hence, do not incur ancillary costs such as residual disposal, monitoring and permit modifications. EPA then used the lower of the two costs for either on-site or off-site treatment. Table 9-6 presents the facilities that EPA costed using off-site treatment.

9.3 Development of Cost Estimates for Individual Treatment Technologies

In Chapter 8, EPA identified and described the wastewater control and treatment technologies used in the Landfills industry. The following sections describe how EPA developed cost estimates for each of the treatment technologies used in the regulatory options. Specific assumptions regarding the equipment used, flow ranges, input and design parameters, design, and cost calculations are discussed for each treatment technology. Table 9-3, previously referenced, presented the method used to estimate costs for each of treatment technologies used in the BPT, BCT, and BAT options. Table 9-7 presents a summary of the

cost-estimation techniques for each treatment technology for the BPT, BCT, and BAT regulatory options, including the WWC treatment module numbers.

To facilitate the costing of many facilities, EPA developed capital and O&M cost curves for specific technologies and system components. The Agency developed these curves, which represent cost as a function of flow rate or other system design parameters, using a commercial statistical software package (Slidewrite Plus Version 2.1). First, EPA developed costs using the WWC model for each technology or component using, as a design basis, five different flow rates or other system design parameters (depending upon the governing design-parameter). For instance, a technology costed on the basis of flow would have costs estimated using the WWC model at 0.01 million gallons per day (MGD), 0.05 MGD, 0.1 MGD, 0.5 MGD, and 1.0 MGD. EPA based the ranges for the five selected points upon a review of the flow- or technology-design parameters for landfill facilities and selected them to represent the range from low to high. Next, EPA entered these five data points (flow/design parameter and associated cost) into a commercial statistical software program. EPA developed cost curves to model the total capital and O&M costs by the program using curve fitting routines. EPA used a second-order natural-log equation format to develop all curves. All cost curves yielded total capital and O&M costs, unless otherwise noted.

9.3.1 Equalization

EPA conducted a review of questionnaire responses to determine the typical hydraulic detention time for equalization. Based upon of review of industry-furnished data, EPA selected a detention time of 48 hours.

EPA based equalization costs developed for each regulatory option on published price quotes for storage tanks. These costs were taken from the 1996 Environmental Restoration Unit Cost Book published by R.S. Means, Inc. EPA developed a cost curve as a function of flow from these tank quotes. The Agency based construction costs upon published data for an above-ground circular steel tank. EPA also included additional costs associated with a wastewater pumping system and diffused aeration to provide sufficient

mixing of tank contents to prohibit settling. The capital cost curve developed for equalization is presented as Equation 9-1 and is graphically presented in Figure 9-2.

Capital Costs

$$\ln(Y) = 15.177382 + 1.981547\ln(X) + 0.15768\ln(X)^2 \quad (9\text{-}1)$$

where:

X = Flow Rate (MGD), and

Y = Capital Cost (1992 $)

The O&M cost for the equation was taken as a function of the capital cost and is based upon 10 percent of the total capital cost per year.

9.3.2 Flocculation

EPA developed a cost curve for flocculation using WWC unit process 72. Costs for flocculation were a function of flow at a hydraulic detention time of 20 minutes. The capital and O&M cost curves developed for flocculation are presented below as Equations 9-2 and 9-3:

Capital Costs

$$\ln(Y) = 11.744579 + 0.633178\ln(X) - 0.015585\ln(X)^2 \quad (9\text{-}2)$$

O&M Costs

$$\ln(Y) = 8.817304 + 0.533382\ln(X) + 0.002427\ln(X)^2 \quad (9\text{-}3)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-3 and 9-4 graphically present the flocculation capital and O&M cost curves, respectively.

EPA based cost estimates for flocculation basins on rectangular-shaped, reinforced concrete structures with a depth of 12 feet and length-to-width ratio of 4:1. The Agency used common wall construction where the total basin volume exceeded 12,500 cubic feet. Vertical-turbine flocculators have higher structural costs than horizontal paddle flocculators because they require structural support above the basin. Horizontal paddles are less expensive and more efficient for use in larger basins, particularly when tapered flocculation is practiced. EPA based manufactured equipment costs on a G value 80 (G is the mean temporal velocity gradient that describes the degree of mixing; i.e., the greater the value of G the greater the degree of mixing). EPA based cost estimates for drive units on variable speed drives for maximum flexibility and, although common drives for two or more parallel basins are often utilized, EPA based the costs on individual drives for each basin.

Energy requirements are based on a G value 80 and an overall motor/mechanism efficiency of 60 percent. The Agency based labor requirements on routine operation and maintenance of 15 minutes/day/basin (maximum basin volume 12,500 cubic ft.) and a 4-hour oil change every 6 months.

9.3.3 Chemical Feed Systems

The following section presents the methodology used to calculate the chemical-addition feed rates used with each applicable regulatory option. Table 9-8 is a breakdown of the design process used for each type of chemical feed. Chemical costs were taken from the September 1992 Chemical Marketing Reporter and are presented in Table 9-9.

For facilities with existing chemical precipitation systems, EPA evaluated the system to determine if it was achieving the regulatory option long-term averages. If the existing system was achieving long-term averages, no additional chemical costs were necessary. However, if the facility was not achieving the long-term averages for an option, EPA estimated costs for an upgrade to the chemical precipitation system.

First, EPA determined the stoichiometric requirements to remove each metal pollutant of interest to the long-term average level. If the current feed rates were within the calculated feed rates, no additional costs were calculated. For facilities currently feeding less than the calculated amounts, EPA estimated costs for an upgrade to add additional precipitation chemicals, such as a coagulant, or expand their existing chemical feed system to accommodate larger dosage rates.

EPA costed facilities without an installed chemical precipitation system for an entire metals precipitation system. The Agency based the chemical feed rates used at a particular facility for either an upgrade or a new system upon stoichiometric requirements, pH adjustments, and the buffering ability of the raw influent.

In the CWT industry guideline, EPA determined that the stoichiometric requirements for chemical addition far outweighed the pH and buffer requirements. EPA determined that 150 percent of the stoichiometric requirement would sufficiently account for pH adjustment and buffering of the solution. The Agency included an additional 50 percent of the stoichiometric requirement to react with metals not on the pollutant of interest list. Finally, EPA added an additional 10 percent increase from the stoichiometric amount as excess. A total of 210 percent of the stoichiometric requirement was estimated when calculating costs for chemical addition systems.

Sodium Hydroxide Feed Systems

The stoichiometric requirement for either lime or hydroxide to remove a particular metal is based upon the following generic equation:

$$lb_{treatment\ chemical} = \left(\frac{lb_{M\ removed}}{year}\right)\left(\frac{valence_{M}}{MW_{M}}\right)\left(\frac{MW_{treatment\ chemical}}{valence_{Na/Ca}}\right)$$

where, M is the target metal and MW is the molecular weight.

The calculated amounts of sodium hydroxide to remove a pound of each of the selected metal pollutants of concern are presented in Table 9-10.

EPA developed sodium hydroxide chemical feed system costs for many facilities using the WWC model. The Agency used reported facility loadings to establish the sodium hydroxide dosage requirement. WWC unit process 45 was used to develop capital and O&M costs for sodium hydroxide feed systems. The capital and O&M cost curves developed for sodium hydroxide feed systems based upon the calculated dosage are presented as Equations 9-4 and 9-5, respectively.

Capital Costs

$$\ln(Y) = 10.653 - 0.184\ln(X) + 0.040\ln(X)^2 \quad (9\text{-}4)$$

O&M Costs

$$\ln(Y) = 8.508 - 0.0464\ln(X) + 0.014\ln(X)^2 \quad (9\text{-}5)$$

where:

X = Dosage Rate (lb/day), and

Y = Cost (1992 $)

Figures 9-5 and 9-6 graphically present the sodium hydroxide feed system capital and O&M cost curves, respectively.

EPA based cost estimates for a sodium hydroxide feed system on WWC unit process 45 for a sodium hydroxide feed rate of between 10 to 10,000 lb/day. EPA based costs on dry sodium hydroxide addition when rates were less than 200 lb/day and on liquid sodium hydroxide when feed rates were higher.

The WWC model assumes that dry sodium hydroxide (98.9 percent pure) is delivered in drums and mixed to a 10 percent solution on site. A volumetric feeder is used to feed sodium hydroxide to one of two tanks: one for mixing the 10 percent solution and one for feeding. Two tanks are necessary for this process because of the slow rate of sodium hydroxide addition due to the high heat of solution. Each tank is equipped with a mixer and a dual-head metering pump, used to convey the 10 percent solution to the point of application. Pipe and valving is required to convey water to the dry sodium hydroxide solution mixing tanks and between the metering pumps and the point of application.

A 50 percent sodium hydroxide solution is purchased premixed and delivered by bulk transport for feed rates greater than 200 lb/day. The 50 percent solution contains 6.38 pounds of sodium hydroxide per gallon and is stored for 15 days in fiberglass reinforced polyester (FRP) tanks. Dual-head metering pumps are used to convey the liquid solution to the point of application, and a standby metering pump is provided in all systems. The storage tanks are located indoors, since 50 percent sodium hydroxide begins to crystallize at temperatures below 54EF.

Phosphoric Acid Feed Systems

In the Subtitle C Hazardous subcategory, phosphoric acid is necessary to neutralize the waste stream and to provide phosphorus to biological treatment systems.

EPA costed the phosphoric acid feed system using the WWC unit process 46. EPA determined that the amount of phosphoric acid necessary to provide nutrient phosphorus was the controlling factor over the amount required for pH adjustment. EPA used a ratio of BOD_5 removed to the amount of phosphorus present in the influent waste stream (100 pounds BOD_5 removed to one pound phosphorus) to determine the amount of phosphoric acid to be added as a nutrient feed to a biological treatment system. To allow for solution buffering, 10 percent excess phosphoric acid was added. The capital and O&M cost curves developed for phosphoric acid feed systems based upon the calculated dosage are presented as Equations 9-6 and 9-7, respectively.

Capital Costs

$$\ln(Y) = 10.042 - 0.155\ln(X) + 0.049\ln(X)^2 \quad (9\text{-}6)$$

O&M Costs

$$\ln(Y) = 7.772 - 0.086\ln(X) + 0.041\ln(X)^2 \quad (9\text{-}7)$$

where:

X = Dosage Rate (gpd), and

Y = Cost (1992 $)

Figures 9-7 and 9-8 graphically present the phosphoric acid feed system capital and O&M cost curves, respectively.

EPA based costs on systems capable of metering 93 percent concentrated acid from a storage tank directly to the point of application. For feed rates up to 200 gpd, the concentrated acid is delivered in drums and stored indoors. At higher flow rates, the acid is delivered in bulk and stored outdoors in FRP tanks. Phosphoric acid is stored for 15 days and a standby metering pump is included for all installations.

Polymer Feed Systems

EPA used WWC unit process 34 to cost for polymer feed systems based upon a dosage rate of 2 mg/L. Although this module estimates costs for a liquid alum feed system, EPA determined that the costs generated by this module were more reasonable and accurate in developing polymer system costs than the WWC unit process 43 for polymer feed systems. The capital and O&M unloaded cost curves developed for polymer feed systems are presented as Equations 9-8 and 9-9, respectively.

Capital Costs

$$\ln(Y) = 10.539595 - 0.13771\ln(X) + 0.052403\ln(X)^2 \quad (9\text{-}8)$$

O&M Costs

$$\ln(Y) = 9.900596 + 0.99703\ln(X) + 0.00019\ln(X)^2 \quad (9\text{-}9)$$

where:

X = Dosage Rate (lb/hr), and

Y = Cost (1992 $)

Figures 9-9 and 9-10 graphically present the polymer feed system capital and O&M cost curves, respectively.

Polymer is stored for 15 days in fiberglass-reinforced polyester tanks. For smaller installations, the tanks are located indoors and left uncovered and, for larger installations, the tanks are covered and vented, with insulation and heating provided. Dual-head metering pumps deliver the polymer from the storage tank and meters the flow to the point of application. Feed costs include 150 feet of 316 stainless steel pipe, along with fittings and valves for each metering pump. A standby metering pump is included for each installation.

9.3.4 Primary Clarification

EPA developed cost curves for primary clarification using WWC unit process 118 for a rectangular basin with a 12 foot side wall depth. EPA based costs for primary clarification upon a function of flow at an overflow rate of 900 gallons per day per square feet tank size. The capital and O&M cost curves developed for primary clarification are presented as Equations 9-10 and 9-11, respectively.

Capital Costs

$$\ln(Y) = 12.517967 + 0.575652\ln(X) + 0.009396\ln(X)^2 \quad (9\text{-}10)$$

O&M Costs

$$\ln(Y) = 10.011664 + 0.268272\ln(X) + 0.00241\ln(X)^2 \quad (9\text{-}11)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-11 and 9-12 graphically present the primary clarification capital and O&M cost curves, respectively.

EPA based estimated costs on rectangular basins with a 12 feet side water depth (SWD) and chain-and-flight sludge collectors. Costs for the structure assumed multiple units with common wall construction and include the chain-and-flight collector, collector drive mechanism, weirs, the reinforced concrete structure complete with inlet and outlet troughs, a sludge sump, and sludge-withdrawal piping. Yard piping to and from the clarifier is not included in the cost estimates.

9.3.5 Activated Sludge Biological Treatment

EPA based costs for biological treatment systems using the activated sludge process using the WWC unit process 18 for a rectangular aeration basin with an 10 foot SWD. EPA determined basin size using a 24 hour hydraulic detention time using Equation 9-12.

$$X = ((24 \text{ Hours} \times 3600) \times (Z))/1{,}000 \qquad (9\text{-}12)$$

where:

X = Basin Volume (1,000 cu ft)

Z = Flow Rate (cfs)

The WWC model assumes zero O&M costs for the aeration basins only. The unloaded (without engineering cost factors applied) capital cost curve developed for aeration basins with an 10 foot SWD is presented as Equation 9-13.

$$\ln(Y) = -1.033901 + 3.722693\ln(X) - 0.197016\ln(X)^2 \quad (9\text{-}13)$$

where:

X = Basin Volume (in thousands of cubic feet), and

Y = Capital Cost (1992 $)

Figure 9-13 graphically presents the aeration basin capital cost curve.

Aeration using diffused air was costed for the basin using WWC unit process 26 and reported facility loading conditions. EPA calculated aeration requirements using the facility BOD_5 and ammonia loadings using Equation 9-14.

$$X = ((A + B)/0.075 \times C \times 0.232 \times 1440)/1{,}000 \quad (9\text{-}14)$$

where:

X = Air Requirement (1,000 standard cubic feet per minute [scfm])

A = BOD_5 to Aeration Basin (lb/day) based on 1.8 lb O_2/lb BOD_5 influent

B = Ammonia to Aeration Basin (lb/day) based on 4.6 lb O_2/lb ammonia influent

C = Transfer Efficiency at 9 percent

The unloaded capital and O&M cost curves developed for air diffusion systems are presented as Equations 9-15 and 9-16, respectively.

Capital Costs

$$\ln(Y) = 11.034417 + 0.992985\ln(X) - 0.002521\ln(X)^2 \quad (9\text{-}15)$$

O&M Costs

$$\ln(Y) = 9.497546 + 0.549715\ln(X) - 0.004216\ln(X)^2 \quad (9\text{-}16)$$

where:

X = Air Requirement (1,000 scfm), and

Y = Cost (1992 $)

Figures 9-14 and 9-15 graphically present the air diffusion system capital and O&M cost curves, respectively.

The costs for aeration basins include all equipment, piping, electrical, and labor for installation. The air-supply system costs include piping from air source to aeration basin, blowers, controls, and housing. Aeration-basin cost estimates include excavation, concrete walkways, in-basin process piping, and handrails and attendant costs, but excludes the cost of aeration equipment, electrical and instrumentation work. EPA considered providing for heated aeration basins for facilities located in cold-weather climates. Based upon data collected by EPA, biological treatment of landfill generated wastewater was not adversely affected by climate conditions.

9.3.6 Secondary Clarification

EPA developed cost curves for secondary clarification using WWC unit process 118 for a rectangular basin with a 12 foot side wall depth with chain-and-flight collectors. EPA based costs for secondary clarification upon a function of flow, at an overflow rate of 900 gallons per day per square feet tank size. The capital and O&M cost curves developed for secondary clarification are presented as Equations 9-17 and 9-18, respectively.

Capital Costs

$$\ln(Y) = 12.834601 + 0.688675\ln(X) + 0.035432\ln(X)^2 \quad (9\text{-}17)$$

O&M Costs

$$\ln(Y) = 10.197762 + 0.339952\ln(X) + 0.015822\ln(X)^2 \quad (9\text{-}18)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-16 and 9-17 graphically present the secondary clarification capital and O&M cost curves, respectively.

Costs for the structure assumed multiple units with common wall construction, and include the chain-and-flight collector, collector drive mechanism, weirs, the reinforced concrete structure, complete with inlet and outlet troughs, a sludge sump, and sludge-withdrawal piping. Yard piping to and from the clarifier is not included in the cost estimates.

9.3.7 Multimedia Filtration

EPA developed cost curves as a function of flow rate for a multimedia filtration system using vendor-supplied quotes. The Agency developed cost curves as part of the CWT effluent guidelines effort. The capital and O&M cost curves developed for multimedia filtration are presented as Equations 9-19 and 9-20, respectively.

Capital Costs

$$\ln(Y) = 12.265 + 0.658\ln(X) + 0.036\ln(X)^2 \quad (9\text{-}19)$$

O&M Costs

$$\ln(Y) = 10.851 + 0.168\ln(X) + 0.018\ln(X)^2 \quad (9\text{-}20)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-18 and 9-19 graphically present the multimedia filtration capital and O&M cost curves, respectively.

The total capital costs for the multimedia filtration systems represent equipment and installation costs. The total construction cost includes the costs of the filter, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the multimedia filtration system was four hours per day.

9.3.8 Reverse Osmosis

EPA developed capital and O&M cost curves as a function of flow rate for reverse osmosis treatment using vendor supplied quotes. EPA based costs on one single-pass system using disk tube module technology. The capital cost curve developed for reverse osmosis is presented as Equation 9-21.

$$\ln(Y) = 14.904 - 0.0142\ln(X) - 0.0687\ln(X)^2 \quad (9\text{-}21)$$

where:

X = Flow Rate (MGD), and

Y = Capital Cost (1992 $)

Figure 9-20 graphically presents the reverse osmosis capital-cost curves. Based upon vendor supplied costs, O&M costs were taken at $0.02/gallon.

Costs for a standard reverse osmosis system generally include the following components: filter booster pump, sand or carbon filter, cartridge filter, high-pressure pump and control system, reverse osmosis module permeators, pure water deacidification filter, in-built closed circuit cleaning system, automatic pure water membrane flushing system, power and control system with microprocessor, full instrumentation and measurement equipment, comprehensive fail-safe system, fault indication, and modular skid frame construction. The costs did not take into account the following optional equipment: main raw-water supply pump, pure water tank and distribution pump, chlorine dosing system, ultra-violet disinfection system, containerized/mobile systems, self-contained power supply, and anti-magnetic systems.

9.3.9 Sludge Dewatering

EPA based costs estimated for sludge dewatering upon sludge-drying beds. EPA costed each facility separately using the WWC unit process 128. EPA based the required bed area upon influent characteristics at a loading of 15 gallons per day of sludge per square foot bed area. EPA calculated drying bed area using Equation 9-22.

$$X = (A \times 365)/B \qquad (9\text{-}22)$$

where:

X = Area (sq ft)

A = Total Dry Solids (lb/day) based on 0.8 lb solids/lb BOD_5 influent

B = 15 lb per year sludge/sq ft

The unloaded capital and O&M cost curves developed for sludge-drying beds are presented as Equations 9-23 and 9-24, respectively.

Capital Costs

$$\ln(Y) = 4.488639 + 0.716471\ln(X) + 0.000005311\ln(X)^2 \qquad (9\text{-}23)$$

O&M Costs

$$\ln(Y) = 6.95049 + 0.33155\ln(X) + 0.002882\ln(X)^2 \quad (9\text{-}24)$$

where:

X = Area (sq ft), and

Y = Cost (1992 $)

Figures 9-21 and 9-22 graphically present the sludge-drying bed capital and O&M cost curves, respectively.

Included in the costs are sludge-distribution piping, nine inches of sand media overlying nine inches of gravel media, two foot concrete dividers between beds, and an underdrain system to remove percolating water. EPA excluded land costs from the cost estimates.

Energy requirements are based on the following: a front-end loader to remove dried sludge from the beds and prepare the bed for the next sludge application, cleaning and preparation time of 3 hours for a 4,000 square foot bed, diesel fuel consumption of 4 gallons per hour, and 20 cleanings/bed/year.

9.3.10 Granular Activated Carbon

EPA developed cost curves as a function of flow rate for a granular activated carbon (GAC) system using vendor-supplied quotes. EPA estimated the capital and O&M costs for GAC using the "Power Plant Wastewater Treatment Technology Review Report", Electric Power Research Institute (EPRI), November 1996, Exhibits A3-1 and D3-1, respectively, and supplemented using "Technologies and Costs for Removal of Arsenic from Drinking Water", Office of Ground Water and Drinking Water, EPA, Draft July 1998. The capital and O&M cost curves developed for GAC adsorption are presented as Equations 9-25 and 9-26, respectively.

Capital Costs

$$\ln(Y) = 12.772 + 0.457\ln(X) - 0.025\ln(X)^2 \quad (9\text{-}25)$$

O&M Costs

$$\ln(Y) = 9.691 - 0.224\ln(X) - 0.041\ln(X)^2 \quad (9\text{-}26)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-23 and 9-24 graphically present the GAC adsorption capital and O&M cost curves, respectively.

The total capital costs for the GAC systems represent equipment and installation costs. The total construction cost includes the costs of the GAC, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include carbon replacement/disposal, energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the GAC system was four hours per day.

9.3.11 Breakpoint Chlorination

EPA developed cost curves as a function of flow rate for a breakpoint chlorination system using vendor-supplied quotes. EPA extrapolated cost estimates for breakpoint chlorination from data supplied by the EPA Office of Ground Water and Drinking Water report. The capital and O&M cost curves developed for a breakpoint chlorination system are presented as Equations 9-27 and 9-28, respectively.

Capital Costs

$$\ln(Y) = 12.219 + 0.051\ln(X) - 0.045\ln(X)^2 \quad (9\text{-}27)$$

O&M Costs

$$\ln(Y) = 12.881 + 0.923\ln(X) + 0.053\ln(X)^2 \quad (9\text{-}28)$$

where:

X = Flow Rate (MGD), and

Y = Cost (1992 $)

Figures 9-25 and 9-26 graphically present the breakpoint chlorination capital and O&M cost curves, respectively.

The total capital costs for the breakpoint chlorination systems represent equipment and installation costs. The total construction cost includes the costs of the chlorine addition unit, instrumentation and controls, pumps, piping, and installation. The operation and maintenance costs include chemical usage, energy usage, maintenance, labor, and taxes and insurance. Energy costs include electricity to run the pumps, lighting, and instrumentation and controls. The labor requirement for the breakpoint chlorination system was four hours per day.

9.4 Costs for Regulatory Options

The following sections present the costs estimated for compliance with the BPT/ BCT/BAT and NSPS effluent limitations guidelines and standards for the Subtitle D Non-Hazardous and Subtitle C Hazardous subcategories. Costs for each of the regulatory options are presented below for only the facilities in the 308 Questionnaire database, as well as for all of the facilities in the Landfills industry based on national estimates (see Chapter 3, Section 3.2.1 for an explanation of national estimates). All costs estimates in this section are expressed in terms of 1992 dollars, unless otherwise noted.

9.4.1 Facility Selection

EPA evaluated each of the 220 Detailed Questionnaires that were returned with sufficient technical and

economic data to determine if the facility would be subject to the final limitations and standards and would, therefore, incur costs as a result of the regulation. EPA determined that 94 of the 220 facilities would not incur costs because of the following reasons:

- 49 facilities indicated that they were zero or alternative discharge
- 40 facilities were operated in conjunction with other industrial or commercial operations and EPA determined that the rule was not applicable to these facilities
- 5 respondents did not generate in-scope wastewater.

EPA calculated costs for each of the remaining 126 facilities and then modeled the national population by using statistically-calculated survey weights. EPA projected the landfill industry costs (presented below) for several technology options based on costs developed for 123 Subtitle D and 3 Subtitle C facilities.

9.4.2 BPT Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select BPT regulatory options. The BPT costs for each subcategory are presented below.

9.4.2.1 Subtitle D Non-Hazardous Subcategory BPT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle D Non-Hazardous subcategory, EPA evaluated two options,BPT Options I and II.

BPT Option I: Equalization and activated sludge biological treatment with secondary clarification, and sludge-dewatering. For the facilities in the 308 Questionnaire database, Table 9-11 presents the total capital ($2,737,104) and annual O&M costs ($838,579) for this option, as well as the total amortized annual cost for each facility. Based on national estimates, BPT Option I for the Subtitle D Non-Hazardous subcategory is estimated to have total annualized pre-tax costs of $7.30 million (based on 1998 dollars).

BPT Option II: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. For the facilities in the 308 Questionnaire database, Table 9-12 presents the total capital ($3,252,453) and annual O&M ($1,027,788) costs for this option, as well as the total amortized annual cost for each facility. Based on national estimates, BPT Option II for the Subtitle D Non-Hazardous subcategory is estimated to have total annualized pre-tax and post-tax costs of $8.57 and $7.64 million (based on 1998 dollars), respectively.

9.4.2.2 Subtitle C Hazardous Subcategory BPT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one BPT option, BPT Option I.

BPT Option I: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. Since EPA did not identify any direct discharge facilities in the Subtitle C Hazardous subcategory database, there are no costs associated with this option.

9.4.3 BCT Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select BCT regulatory options. The BCT costs for each subcategory are presented below.

9.4.3.1 Subtitle D Non-Hazardous Subcategory BCT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle D Non-Hazardous subcategory, EPA evaluated two options, BCT Option I and II.

BCT Option I: Equalization and activated sludge biological treatment with secondary clarification, and sludge-dewatering. This option is equivalent to BPT Option I for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

BCT Option II: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option II for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

9.4.3.2 Subtitle C Hazardous Subcategory BCT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one option, BCT Option I.

BCT Option I: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option I for the Subtitle C Hazardous subcategory and, therefore, has no associated costs.

9.4.4 BAT Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select BAT regulatory options. The BAT costs for each subcategory are presented below.

9.4.4.1 Subtitle D Non-Hazardous Subcategory BAT Costs

EPA costed three BAT options for the Subtitle D Non-Hazardous subcategory: BAT Options I, II and III.

BAT Option I: Equalization and activated sludge biological treatment with secondary clarification, and sludge-dewatering. This option is equivalent to BPT Option I for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

BAT Option II: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option II for the Non-Hazardous subcategory with costs previously provided in Section 9.4.2.1 above.

BAT Option III: Equalization, activated sludge biological treatment, multimedia filtration, and reverse osmosis with sludge-dewatering. For facilities in the 308 Questionnaire database, Table 9-13 presents the total capital ($34,518,089) and annual O&M ($5,896,531) costs for this option as well as the total amortized annual cost for each facility. Based on national estimates, BAT Option III for the Subtitle D Non-Hazardous subcategory is estimated to have a total annualized pre-tax cost of $45.95 million (based on 1998 dollars).

9.4.4.2 Subtitle C Hazardous Subcategory BAT Costs

Once EPA developed current discharge and untreated landfill wastewater pollutant concentrations for facilities in the Subtitle C Hazardous subcategory, EPA evaluated one BAT option, BPT Option I.

BAT Option I: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. This option is equivalent to BPT Option I for the Hazardous subcategory and, therefore, has no associated costs.

9.4.5 NSPS Regulatory Costs

EPA developed preliminary cost-effectiveness analyses using interim costing-rounds to select NSPS regulatory options. The NSPS costs for each subcategory are presented below.

9.4.5.1 Subtitle D Non-Hazardous Subcategory NSPS Costs

EPA is establishing NSPS for the Subtitle D Non-Hazardous subcategory to be equivalent to the limitations established for BPT Option II for this subcategory, which also is the basis for BCT and BAT.

NSPS: Equalization, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. The total NSPS annual cost for the Non-Hazardous subcategory is $52,755 assuming an average facility flow of 10,000 gpd.

9.4.5.2 Subtitle C Hazardous Subcategory NSPS Costs

EPA is establishing NSPS for the Subtitle C Hazardous subcategory to be equivalent to the limitations established for BPT Option I for this subcategory, which also is the basis for BCT and BAT.

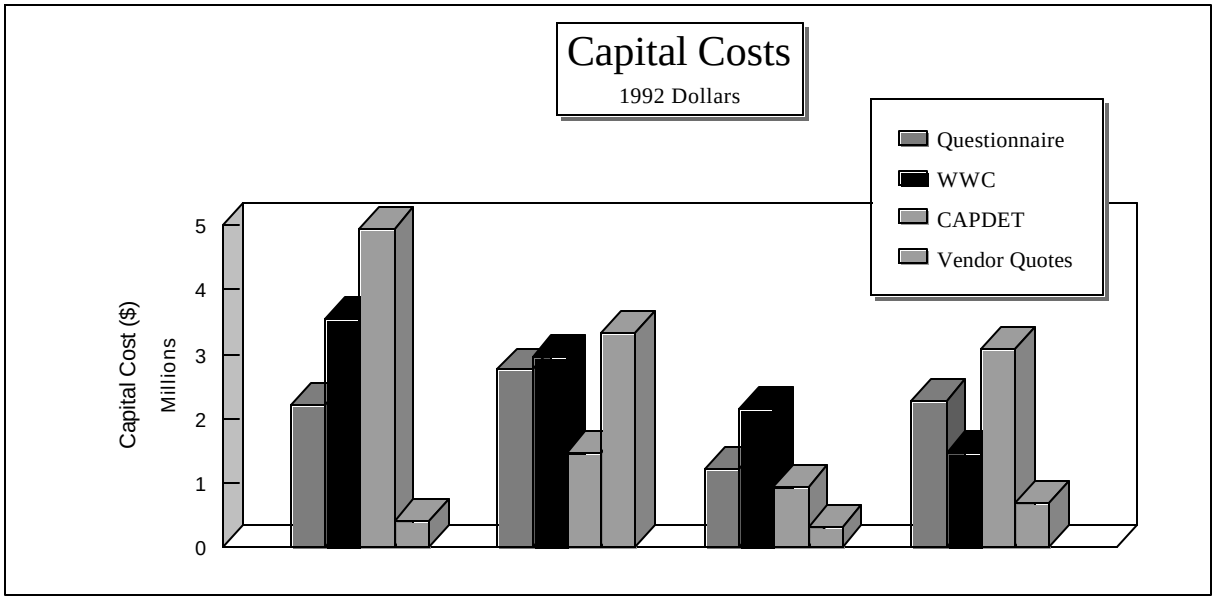
NSPS: Equalization, chemical precipitation, activated sludge biological treatment with secondary clarification, multimedia filtration, and sludge-dewatering. The total NSPS annual cost for the Hazardous subcategory is $132,031 assuming an average facility flow of 10,000 gpd.

Table 9-1: Cost Comparison

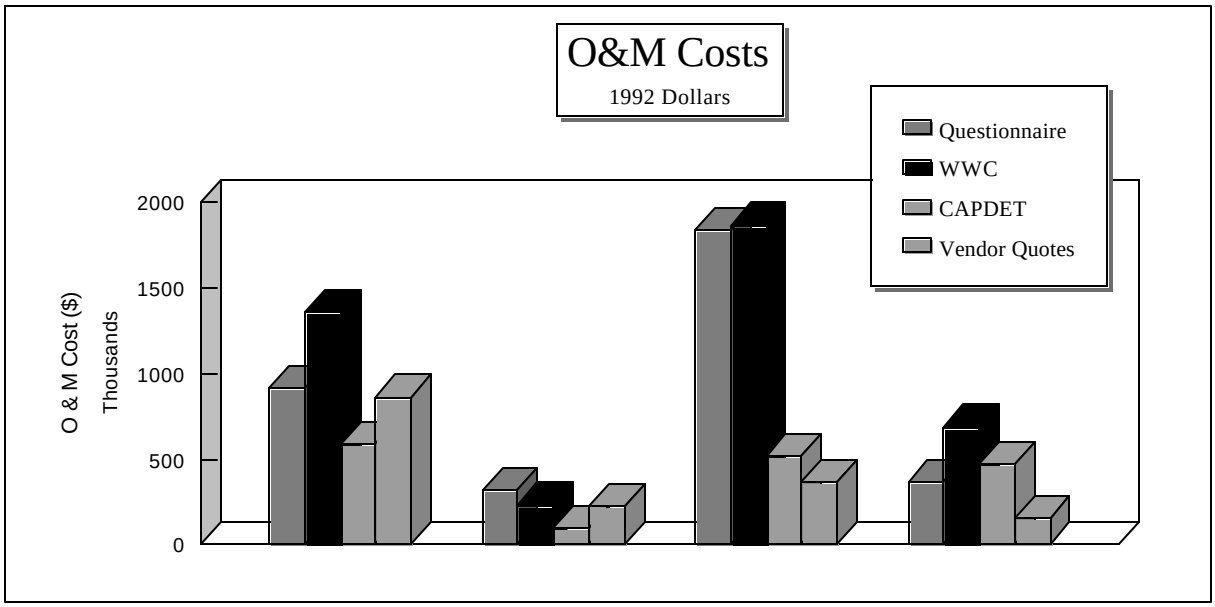
Facility QID	Treatment Train	CAPDET Computer Run		WWC Engineering Software		Vendor Quotes		Questionnaire Responses	
		Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs	Capital Cost 1992	O&M Costs
16122	Chemical Precipitation	$232,366	$178,773	$190,308	$41,883	$177,504	$163,397	NA	$22,858
	Above+Anaerobic&Aerobic Bio	$1,217,370	$353,181	$836,433	$79,898	$794,343	$305,669	NA	$133,314
	Above+2nd Chemical Precipitation	$1,449,732	$587,637	$908,201	$91,295	$971,847	$469,066	NA	$133,872
	Above+Equalization+Multimedia Filter	$1,517,811	$715,088	$1,573,621	$91,295	$1,553,010	$543,840	NA	$133,872
	Equalization	$58,478	$69,475	$692,252	$1,997	$526,532	$36,442	NA	$3,388
	Entire Treatment Train	$1,576,289	$784,563	$2,782,188	$317,747	$2,154,117	$586,240	$4,113,628	$311,400
16125	Equalization+Air Stripping	$57,717	$61,556	$394,570	$20,718	$243,800	$54,147	$588,714	$8,247
	Chemical Precipitation+SBR	$282,073	$255,294	$1,928,245	$103,100	(a)	(a)	$2,067,188	$31,534
	Above+Carbon+Multimedia Filter	$478,266	$460,622	$2,492,431	$145,949	(b)	(b)	$2,534,242	$34,883
16087	Entire Treatment Train	NA	NA	$2,519,307	$816,351	(c)	(c)	$2,423,057	$992,578
16041	SBR+Sludge Equipment	$159,908	$115,066	$2,378,898	$436,879	NA	NA	$6,293,919	$460,050

NA: Not Available
(a): Capital O&M costs without the SBR are $82,675 and $56,972, respectively
(b): Capital O&M costs without the SBR are $140,078 and $106,642, respectively
(c): Capital O&M costs without the activated sludge system and chlorine addition are $189,120 and $100,849, respectively

Table 9-2: Costing Source Comparison



	Chem Precip	Chem Precip and Filtration	Chem Precip	2-stage Chem Precip
Questionnaire	2,206,980	2,751,204	1,214,563	2,265,009
WWC	3,543,264	2,950,035	2,144,446	1,476,821
CAPDET	4,948,779	1,475,480	942,216	3,072,253
Vendor Quotes	399,878	3,314,930	319,206	670,158



	Chem Precip	Chem Precip and Filtration	Chem Precip	2-stage Chem Precip
Questionnaire	910,000	315,000	1,837,000	363,000
WWC	1,355,505	231,728	1,864,219	686,360
CAPDET	585,855	99,036	515,859	466,848
Vendor Quotes	860,867	222,135	361,623	151,889

Table 9-3: Breakdown of Costing Method by Treatment Technology

Treatment Technology	Cost Using WWC Program	Cost Using Vendor Quotes	Key Design Parameter(s)
Equalization		X(a)	Flow rate
Flocculation	X		Flow rate
Chemical Feed System	X		Flow rate & Pollutant of Interest Metals
Primary & Secondary Clarification	X		Flow rate
Activated Sludge	X		Flow rate, BOD_5, & Ammonia
Reverse Osmosis		X	Flow rate
Multimedia Filtration		X(b)	Flow rate
Activated Carbon		X(c)	Flow rate
Breakpoint Chlor.		X(d)	Flow rate
Sludge-Drying Beds	X		Flow rate, TSS & BOD_5

(a) Based upon costs provided in Environmental Restoration Unit Cost Book

(b) Cost curves developed using vendor quotes in the CWT guideline effort

(c) Based upon costs provided in "Power Plant Wastewater Treatment Technology Review Report", Electric Power Research Institute (EPRI), November 1996, Exhibits A3-1 and D3-1, respectively, and supplemented using "Technologies and Costs for Removal of Arsenic from Drinking Water", Office of Ground Water and Drinking Water, EPA, Draft July 1998

(d) Costs were extrapolated from data supplied by the EPA Office of Ground Water and Drinking Water report

Table 9-4: Additional Cost Factors

Type	Factor	Percent of Capital Cost
Capital	Site Work & Interface Piping	18
	General Contractor Overhead	10
	Engineering	12
	Instrumentation & Controls	13
	Buildings	6
	Site Improvements	10
	Legal, Fiscal, & Administrative	2
	Interest During Construction	9
	Contingency	8
	Retrofit (if necessary)	20
O&M	Taxes & Insurance	2[1]

(1) 2 percent of total capital costs, which includes WWC costs and capital costs listed above.

Table 9-5: Analytical Monitoring Costs

Pollutants	Cost/Sample ($)[1]
Subtitle D Non-Hazardous	
Ammonia as N	18.00
BOD_5	15.00
TSS	6.00
Metals & Organics	105.00
Subtitle C Hazardous	
Ammonia as N	18.00
BOD_5	15.00
TSS	6.00
Metals & Volatile/Semi-Volatile Organics	1600.00

(1) Cost based on 1995 analytical laboratory costs adjusted to 1992 dollars.

Table 9-6: Subtitle D Non-Hazardous Facilities Costed for Off-Site Disposal

Facility QID	Flow (gpd)	Off-Site Disposal Cost ($/yr)
16048	5	730
16055	8	1168
16062	50	7300
16139	50	7300
16148	77	11242
16160	137	20002
16250	200	29200

Table 9-7: Unit Process Breakdown by Regulatory Option

Treatment Technology Description	Subcategory		WWC Unit Process #*	WWC Unit Process # Description
	Non-Hazardous	Hazardous		
Equalization & activated sludge	BPT/BCT/BAT Option I		NA	equalization
			18	aeration basin
			26	aeration system
			118	secondary clarification
			128	sludge dewatering
Equalization, activated sludge & multimedia filtration	BPT/BCT/BAT Option II NSPS		NA	equalization
			18	aeration basin
			26	aeration system
			118	secondary clarification
			NA	multimedia filtration
			128	sludge dewatering
Equalization, activated sludge, multimedia filtration & single-stage reverse osmosis	BAT Option III		NA	equalization
			18	aeration basin
			26	aeration system
			118	secondary clarification
			NA	multimedia filtration
			NA	single-stage reverse osmosis
			128	sludge dewatering
Equalization, chemical precipitation, activated sludge & multimedia filtration		BPT/BCT/BAT Option I NSPS	NA	equalization
			72	flocculation tank
			45	sodium hydroxide feed system
			34	polymer feed system
			118	primary clarification
			46	phosphoric acid feed system
			18	aeration basin
			26	aeration system
			118	secondary clarification
			NA	multimedia filtration
			128	sludge dewatering

*NA=Not Applicable-Vendor Quotes Used

Table 9-8: Chemical Addition Design Method

Chemical	Basis for Design	
	Stoichiometry	Reference[1] (mg/L)
Sodium Hydroxide	X	
Polymer		2.0
Phosphoric Acid	X	

(1) From: Industrial Water Pollution Control, 2nd Edition.

Table 9-9: Treatment Chemical Costs

Treatment Chemical	Cost
Sodium Hydroxide	$350/ton
Polymer	$2.25/lb
Phosphoric Acid	$300/ton

Table 9-10: Sodium Hydroxide Requirements for Chemical Precipitation

Pollutant	Dosage Rate Sodium Hydroxide (lb/lb metal removed)
Cadmium	0.71
Chromium, total	2.31
Iron	2.15
Nickel	2.04
Zinc	1.22
Phosphorus	6.46

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory

		CAPITAL COSTS ($)						AMORTIZED	O&M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O&M	ANNUAL COST ($/YR)(b)
16001	0.0793	153,015	2,004	31,004	0	0	186,023	20,424	19,637	4,078	11,540	35,255	55,679
16003	0.00472	0	0	0	0	0	0	0	0	0	0	0	0
16008	0	0	0	0	0	0	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0	0	0	0	0	0
16012	0.00221	0	0	0	0	0	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16016	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16020	0.04581	0	0	0	0	0	0	0	0	0	0	0	0
16023	0.05734	0	0	0	0	0	0	0	0	0	0	0	0
16024	0.00592	0	0	0	0	0	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0	0	0	0	0	0
16038	0.00822	0	0	0	0	0	0	0	0	0	0	0	0
16039	0.00178	0	0	0	0	0	0	0	0	0	0	0	0
16043	0.00218	0	0	0	0	0	0	0	0	0	0	0	0
16044	0	0	0	0	0	0	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0	0	0	0	0	0
16047	0.00115	38,175	2,004	0	0	0	40,179	4,411	8,760	1,917	11,540	22,217	26,628
16048	5E-06	0	0	0	0	0	0	0	0	0	0	0	730
16049	0.0017	35,037	2,004	7,408	0	0	44,449	4,880	8,302	2,208	11,540	22,050	26,930
16050	0.01	58,533	2,004	0	0	0	60,537	6,647	11,672	1,917	11,540	25,129	31,776
16052	0.0546	217,678	5,563	44,648	0	0	267,889	29,413	17,799	6,897	11,072	35,768	65,180
16053	0.00124	39,625	2,004	0	0	0	41,629	4,571	9,002	1,917	11,540	22,459	27,030
16054	0.00075	16,544	2,004	3,710	0	0	22,258	2,444	5,276	1,917	11,357	18,550	20,994
16055	8E-06	0	0	0	0	0	0	0	0	0	0	0	1,168
16056	0.00137	40,636	2,004	0	0	0	42,640	4,682	8,921	1,917	11,540	22,378	27,060
16058	0.003	44,348	2,004	9,270	0	0	55,622	6,107	8,936	1,917	0	10,853	16,960
16059	0.0011	38,017	2,004	0	0	0	40,021	4,394	8,730	1,917	11,540	22,187	26,581
16060	0.0018	43,919	2,004	0	0	0	45,923	5,042	9,178	2,208	11,540	22,926	27,968

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O&M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O&M	ANNUAL COST ($/YR)(b)
16061	0	0	0	0	0	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0	0	0	0	0	7,300
16063	0.0067	75,309	2,004	0	0	0	77,313	8,489	11,152	3,562	11,540	26,254	34,742
16064	0.01197	62,083	2,004	0	0	0	64,087	7,036	12,127	3,931	11,540	27,598	34,634
16065	0.008	71,448	2,004	14,690	0	0	88,143	9,678	10,481	3,231	11,090	24,802	34,480
16068	0	0	0	0	0	0	0	0	0	0	0	0	0
16070	0.00133	0	0	0	0	0	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0	0	0	0	0	0
16072	0	0	0	0	0	0	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0	0	0	0	0	0
16075	0.01021	0	0	0	0	0	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0	0	0	0	0	0
16079	0.11247	344,770	0	68,954	0	0	413,724	45,425	23,219	0	11,180	34,399	79,824
16083	0.001	29,000	2,004	6,201	0	0	37,205	4,085	7,835	1,735	11,540	21,110	25,195
16084	0.00643	0	0	0	0	0	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0	0	0	0	0	0
16090	0.00393	0	0	0	0	0	0	0	0	0	0	0	0
16091	0.2321	0	0	0	0	0	0	0	0	0	0	0	0
16092	0.00668	0	0	0	0	0	0	0	0	0	0	0	0
16093	0.08158	222,598	0	44,520	0	0	267,118	29,328	30,361	0	11,180	41,541	70,869
16097	0.019	0	0	0	0	0	0	0	0	0	10,520	10,520	10,520
16098	0	0	0	0	0	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0	0	0	0	0	0
16102	0.01394	110,824	0	22,165	0	0	132,989	14,602	13,163	0	11,540	24,703	39,304
16103	0.03756	0	0	0	0	0	0	0	0	0	0	0	0
16107	0.00129	0	0	0	0	0	0	0	0	0	0	0	0
16109	0.05056	0	0	0	0	0	0	0	0	0	0	0	0
16111	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0	0	0	0	0	0
16115	0.00407	0	0	0	0	0	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0	0	0	0	0	0
16117	0.04	0	0	0	0	0	0	0	0	0	9,908	9,908	9,908

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16118	0.0288	0	0	0	0	0	0	0	0	0	0	0	0
16119	0.00729	13,151	2,004	3,031	0	0	18,186	1,997	2,577	1,948	11,117	15,642	17,639
16120	0.04278	0	0	0	0	0	0	0	0	0	9,200	9,200	9,200
16121	0.08028	0	0	0	0	0	0	0	0	0	0	0	0
16122	0.0255	0	0	0	0	0	0	0	0	0	9,948	9,948	9,948
16123	0.04608	206,903	8,080	42,997	0	0	257,980	28,325	19,430	8,365	11,540	39,335	67,660
16124	0.01666	0	0	0	0	0	0	0	0	0	0	0	0
16125	0.01419	0	0	0	0	0	0	0	0	0	10,712	10,712	10,712
16127	0.00363	48,545	2,004	10,110	0	0	60,659	6,660	9,190	2,756	11,540	23,486	30,146
16128	0.00396	0	0	0	0	0	0	0	0	0	0	0	0
16129	0.00469	0	0	0	0	0	0	0	0	0	11,540	11,540	11,540
16130	0.0003	4,400	2,004	1,281	0	0	7,685	844	10,400	4,078	11,540	26,018	26,862
16131	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16135	0.01149	0	0	0	0	0	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0	0	0	0	0	0
16140	0	0	0	0	0	0	0	0	0	0	0	0	0
16143	0	0	0	0	0	0	0	0	0	0	0	0	0
16144	0	0	0	0	0	0	0	0	0	0	0	0	0
16146	0	0	0	0	0	0	0	0	0	0	0	0	0
16148	0.00008	0	0	0	0	0	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0	0	0	0	0	0
16150	0.04578	0	0	0	0	0	0	0	0	0	0	0	0
16151	0.00205	0	0	0	0	0	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0	0	0	0	0	0
16154	0.01022	0	0	0	0	0	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0	0	0	0	0	0
16158	0.01428	0	0	0	0	0	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0	0	0	0	0	0
16160	0.00014	0	0	0	0	0	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16165	0.03022	0	0	0	0	0	0	0	0	0	0	0	0
16166	0.00342	0	0	0	0	0	0	0	0	0	0	0	0
16169	0	0	0	0	0	0	0	0	0	0	0	0	0
16170	0.0048	55,201	2,004	11,441	0	0	68,647	7,537	9,594	4,078	11,235	24,907	32,444
16171	0.024	0	0	0	0	0	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0	0	0	0	0	0
16176	0.03727	0	0	0	0	0	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0	0	0	0	0	0
16184	0	0	0	0	0	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0	0	0	0	0	0
16190	0	0	0	0	0	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0	0	0	0	0	0
16193	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16196	0.01223	108,110	11,645	0	0	0	119,755	13,148	14,487	10,115	11,540	36,142	49,290
16197	0	0	0	0	0	0	0	0	0	0	0	0	0
16199	0.0008	0	0	0	0	0	0	0	0	0	0	0	0
16200	0.01142	0	0	0	0	0	0	0	0	0	0	0	0
16201	0.00188	0	0	0	0	0	0	0	0	0	0	0	0
16202	0.01301	0	0	0	0	0	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0	0	0	0	0	0
16206	0.05739	0	0	0	0	0	0	0	0	0	0	0	0
16208	0.00334	0	0	0	0	0	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0	0	0	0	0	0
16212	0.0007	15,300	2,004	0	0	0	17,304	1,900	18,800	1,516	10,500	30,816	32,716
16215	0	0	0	0	0	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0	0	0	0	0	0
16219	0.02544	0	0	0	0	0	0	0	0	0	0	0	0
16220	0.03041	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-11: BPT/BCT/BAT Option I Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16221	0.00662	0	0	0	0	0	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0	0	0	0	0	0
16222	0	0	0	0	0	0	0	0	0	0	0	0	0
16223	0.02904	153,000	2,004	0	0	0	155,004	17,019	51,200	4,078	10,500	65,778	82,797
16224	0	0	0	0	0	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0	0	0	0	0	0
16228	0.00072	0	0	0	0	0	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0	0	0	0	0	0
16231	0	0	0	0	0	0	0	0	0	0	0	0	0
16232	0	0	0	0	0	0	0	0	0	0	0	0	0
16233	0.0097	94,269	9,868	0	0	0	104,137	11,434	13,366	9,277	11,540	34,183	45,617
16234	0.03083	0	0	0	0	0	0	0	0	0	0	0	0
16236	0.00595	0	0	0	0	0	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0.0056	0	0	0	0	0	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16243	0	0	0	0	0	0	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0	0	0	0	0	0
16246	0.00135	0	0	0	0	0	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0	0	0	0	0	0
16253	0.01776	0	0	0	0	0	0	0	0	0	11,068	11,068	11,068
TOTALS	2.694	2,340,439	75,236	321,429	0	0	2,737,104	300,519	373,594	87,480	368,307	829,381	1,139,098

(a) Amortization assuming 7% interest over 15 year period.

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-12: BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory

ID#	Flow (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital		Equipment	Solids Handling	Monitoring	Total O & M	
16001	0.0793	203,456	2,004	41,092	0	0	246,552	27,070	44,857	4,078	11,540	60,475	87,545
16003	0.00472	0	0	0	0	0	0	0	0	0	0	0	0
16008	0	0	0	0	0	0	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0	0	0	0	0	0
16012	0.00221	0	0	0	0	0	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16016	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16020	0.04581	0	0	0	0	0	0	0	0	0	0	0	0
16023	0.05734	0	0	0	0	0	0	0	0	0	0	0	0
16024	0.00592	0	0	0	0	0	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0	0	0	0	0	0
16038	0.00822	0	0	0	0	0	0	0	0	0	0	0	0
16039	0.00178	0	0	0	0	0	0	0	0	0	0	0	0
16043	0.00218	0	0	0	0	0	0	0	0	0	0	0	0
16044	0	0	0	0	0	0	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0	0	0	0	0	0
16047	0.00115	51,650	2,004	0	0	0	53,654	5,891	15,497	1,917	11,540	28,954	34,845
16048	5E-06	0	0	0	0	0	0	0	0	0	0	0	730
16049	0.0017	48,843	2,004	10,169	0	0	61,017	6,699	15,205	2,208	11,540	28,953	35,653
16050	0.01	58,533	2,004	0	0	0	60,537	6,647	11,672	1,917	11,540	25,129	31,776
16052	0.0546	217,678	5,563	44,648	0	0	267,889	29,413	17,799	6,897	11,072	35,768	65,180
16053	0.00124	39,625	2,004	0	0	0	41,629	4,571	9,002	1,917	11,540	22,459	27,030
16054	0.00075	30,019	2,004	6,405	0	0	38,427	4,219	12,013	1,917	11,357	25,287	29,506
16055	8E-06	0	0	0	0	0	0	0	0	0	0	0	1,168
16056	0.00137	54,111	2,004	0	0	0	56,115	6,161	15,659	1,917	11,540	29,116	35,277
16058	0.003	44,348	2,004	9,270	0	0	55,622	6,107	8,936	1,917	0	10,853	16,960
16059	0.0011	51,492	2,004	0	0	0	53,496	5,874	15,468	1,917	11,540	28,925	34,798
16060	0.0018	57,885	2,004	0	0	0	59,889	6,575	16,161	2,208	11,540	29,909	36,484
16061	0	0	0	0	0	0	0	0	0	0	0	0	0
16062	0.00005	0	0	0	0	0	0	0	0	0	0	0	7,300
16063	0.0067	94,714	2,004	0	0	0	96,718	10,619	20,855	3,562	11,540	35,957	46,576
16064	0.01197	62,083	2,004	0	0	0	64,087	7,036	12,127	3,931	11,540	27,598	34,634

Table 9-12: BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital		Equipment	Solids Handling	Monitoring	Total O & M	
16065	0.008	91,929	2,004	18,787	0	0	112,719	12,376	20,721	3,231	11,090	35,042	47,418
16068	0	0	0	0	0	0	0	0	0	0	0	0	0
16070	0.00133	0	0	0	0	0	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0	0	0	0	0	0
16072	0	0	0	0	0	0	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0	0	0	0	0	0
16075	0.01021	0	0	0	0	0	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0	0	0	0	0	0
16079	0.11247	356,066	0	71,213	0	0	427,279	46,913	27,018	0	11,180	38,198	85,111
16083	0.001	42,475	2,004	8,896	0	0	53,374	5,860	14,573	1,735	11,540	27,848	33,708
16084	0.00643	0	0	0	0	0	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0	0	0	0	0	0
16090	0.00393	0	0	0	0	0	0	0	0	0	0	0	0
16091	0.2321	0	0	0	0	0	0	0	0	0	0	0	0
16092	0.00668	0	0	0	0	0	0	0	0	0	0	0	0
16093	0.08158	222,598	0	44,520	0	0	267,118	29,328	30,361	0	11,180	41,541	70,869
16097	0.019	72,380	0	14,476	0	0	86,856	9,536	3,597	0	10,520	14,117	23,653
16098	0	0	0	0	0	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0	0	0	0	0	0
16102	0.01394	135,429	0	27,086	0	0	162,514	17,843	25,465	0	11,540	37,005	54,848
16103	0.03756	0	0	0	0	0	0	0	0	0	0	0	0
16107	0.00129	0	0	0	0	0	0	0	0	0	0	0	0
16109	0.05056	0	0	0	0	0	0	0	0	0	0	0	0
16111	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0	0	0	0	0	0
16115	0.00407	0	0	0	0	0	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0	0	0	0	0	0
16117	0.04	37,048	0	7,410	0	0	44,458	4,881	18,524	0	9,908	28,432	33,313
16118	0.0288	0	0	0	0	0	0	0	0	0	0	0	0
16119	0.00729	13,151	2,004	3,031	0	0	18,186	1,997	2,577	1,948	11,117	15,642	17,639
16120	0.04278	0	0	0	0	0	0	0	0	0	9,200	9,200	9,200
16121	0.08028	0	0	0	0	0	0	0	0	0	0	0	0
16122	0.0255	0	0	0	0	0	0	0	0	0	9,948	9,948	9,948
16123	0.04608	246,283	8,080	50,873	0	0	305,236	33,513	39,120	8,365	11,540	59,025	92,538
16124	0.01666	0	0	0	0	0	0	0	0	0	0	0	0
16125	0.01419	0	0	0	0	0	0	0	0	0	10,712	10,712	10,712

Table 9-12: BPT/BCT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)	O&M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital		Equipment	Solids Handling	Monitoring	Total O&M	
16127	0.00363	55,540	2,004	11,509	0	0	69,053	7,582	11,684	2,756	11,540	25,980	33,562
16128	0.00396	0	0	0	0	0	0	0	0	0	0	0	0
16129	0.00469	0	0	0	0	0	0	0	0	0	11,540	11,540	11,540
16130	0.0003	4,400	2,004	1,281	0	0	7,685	844	10,400	4,078	11,540	26,018	26,862
16131	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16135	0.01149	0	0	0	0	0	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0	0	0	0	0	0
16140	0	0	0	0	0	0	0	0	0	0	0	0	0
16143	0	0	0	0	0	0	0	0	0	0	0	0	0
16144	0	0	0	0	0	0	0	0	0	0	0	0	0
16146	0	0	0	0	0	0	0	0	0	0	0	0	0
16148	0.00008	0	0	0	0	0	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0	0	0	0	0	0
16150	0.04578	0	0	0	0	0	0	0	0	0	0	0	0
16151	0.00205	0	0	0	0	0	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0	0	0	0	0	0
16154	0.01022	0	0	0	0	0	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0	0	0	0	0	0
16158	0.01428	0	0	0	0	0	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0	0	0	0	0	0
16160	0.00014	0	0	0	0	0	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16165	0.03022	0	0	0	0	0	0	0	0	0	0	0	0
16166	0.00342	0	0	0	0	0	0	0	0	0	0	0	0
16169	0	0	0	0	0	0	0	0	0	0	0	0	0
16170	0.0048	55,201	2,004	11,441	0	0	68,647	7,537	9,594	4,078	11,235	24,907	32,444
16171	0.024	0	0	0	0	0	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0	0	0	0	0	0
16176	0.03727	0	0	0	0	0	0	0	0	0	0	0	0
16177	0	0	0	0	0	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0	0	0	0	0	0
16184	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-12: BCT/BPT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)	O&M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital		Equipment	Solids Handling	Monitoring	Total O&M	
16185	0	0	0	0	0	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0	0	0	0	0	0
16190	0	0	0	0	0	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0	0	0	0	0	0
16193	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16196	0.01223	131,628	11,645	0	0	0	143,273	15,731	26,246	10,115	11,540	47,901	63,632
16197	0	0	0	0	0	0	0	0	0	0	0	0	0
16199	0.0008	0	0	0	0	0	0	0	0	0	0	0	0
16200	0.01142	0	0	0	0	0	0	0	0	0	0	0	0
16201	0.00188	0	0	0	0	0	0	0	0	0	0	0	0
16202	0.01301	0	0	0	0	0	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0	0	0	0	0	0
16206	0.05739	0	0	0	0	0	0	0	0	0	0	0	0
16208	0.00334	0	0	0	0	0	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0	0	0	0	0	0
16212	0.0007	15,300	2,004	0	0	0	17,304	1,900	18,800	1,516	10,500	30,816	32,716
16215	0	0	0	0	0	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0	0	0	0	0	0
16219	0.02544	0	0	0	0	0	0	0	0	0	0	0	0
16220	0.03041	0	0	0	0	0	0	0	0	0	0	0	0
16221	0.00662	0	0	0	0	0	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0	0	0	0	0	0
16222	0	0	0	0	0	0	0	0	0	0	0	0	0
16223	0.02904	153,000	2,004	0	0	0	155,004	17,019	51,200	4,078	10,500	65,778	82,797
16224	0	0	0	0	0	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0	0	0	0	0	0
16228	0.00072	0	0	0	0	0	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0	0	0	0	0	0
16231	0	0	0	0	0	0	0	0	0	0	0	0	0
16232	0	0	0	0	0	0	0	0	0	0	0	0	0
16233	0.0097	116,040	9,868	0	0	0	125,908	13,824	24,252	9,277	11,540	45,069	58,893
16234	0.03083	0	0	0	0	0	0	0	0	0	0	0	0
16236	0.00595	0	0	0	0	0	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0.0056	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-12: BCT/BPT/BAT Option II Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O&M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O&M	TOTAL ANNUAL COST ($/YR)(b)
16241	0	0	0	0	0	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16243	0	0	0	0	0	0	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0	0	0	0	0	0
16246	0.00135	0	0	0	0	0	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0	0	0	0	0	0
16253	0.01776	26,840	0	5,368	0	0	32,208	3,536	13,420	0	11,068	24,488	28,024
TOTALS	2.694	2,789,743	75,236	387,473	0	0	3,252,453	357,102	562,803	87,480	368,307	1,018,590	1,384,890

(a) Amortization assuming 7% interest over 15 year period.

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory

ID#	Flow (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)	O & M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital		Equipment	Solids Handling	Monitoring	Total O & M	
16001	0.0793	2,183,593	2,004	437,119	0	0	2,622,716	287,960	623,747	4,078	11,540	639,365	927,325
16003	0.00472	0	0	0	0	0	0	0	0	0	0	0	0
16008	0	0	0	0	0	0	0	0	0	0	0	0	0
16009	0.01613	0	0	0	0	0	0	0	0	0	0	0	0
16011	0	0	0	0	0	0	0	0	0	0	0	0	0
16012	0.00221	0	0	0	0	0	0	0	0	0	0	0	0
16013	0.015	0	0	0	0	0	0	0	0	0	0	0	0
16014	0	0	0	0	0	0	0	0	0	0	0	0	0
16015	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16016	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16020	0.04581	0	0	0	0	0	0	0	0	0	0	0	0
16023	0.05734	0	0	0	0	0	0	0	0	0	0	0	0
16024	0.00592	0	0	0	0	0	0	0	0	0	0	0	0
16025	0	0	0	0	0	0	0	0	0	0	0	0	0
16026	0	0	0	0	0	0	0	0	0	0	0	0	0
16027	0	0	0	0	0	0	0	0	0	0	0	0	0
16028	0.01985	0	0	0	0	0	0	0	0	0	0	0	0
16029	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16033	0.0091	0	0	0	0	0	0	0	0	0	0	0	0
16035	0	0	0	0	0	0	0	0	0	0	0	0	0
16038	0.00822	0	0	0	0	0	0	0	0	0	0	0	0
16039	0.00178	0	0	0	0	0	0	0	0	0	0	0	0
16043	0.00218	0	0	0	0	0	0	0	0	0	0	0	0
16044	0	0	0	0	0	0	0	0	0	0	0	0	0
16046	0	0	0	0	0	0	0	0	0	0	0	0	0
16047	0.00115	191,967	2,004	0	0	0	193,971	21,297	23,878	1,917	11,540	37,335	58,632
16048	5E-06	46,193	0	0	0	0	46,193	5,072	14,452	0	0	14,452	20,254
16049	0.0017	247,768	2,004	49,954	0	0	299,726	32,908	27,615	2,208	11,540	41,363	74,272
16050	0.01	797,074	2,004	0	0	0	799,078	87,734	84,672	1,917	11,540	98,129	185,864
16052	0.0546	1,949,079	5,563	390,928	0	0	2,345,571	257,531	416,379	6,897	11,072	434,348	691,879
16053	0.00124	190,146	2,004	0	0	0	192,150	21,097	18,054	1,917	11,540	31,511	52,609
16054	0.00075	123,852	2,004	25,171	0	0	151,028	16,582	17,488	1,917	11,357	30,762	47,344
16055	8E-06	32,864	0	0	0	0	32,864	3,608	7,737	0	0	7,737	12,513
16056	0.00137	218,417	2,004	0	0	0	220,421	24,201	25,638	1,917	11,540	39,095	63,296
16058	0.003	361,815	2,004	72,764	0	0	436,583	47,934	30,836	1,917	0	32,753	80,688
16059	0.0011	186,408	2,004	0	0	0	188,412	20,687	23,498	1,917	11,540	36,955	57,641
16060	0.0018	266,809	2,004	0	0	0	268,813	29,514	29,301	2,208	11,540	43,049	72,563
16061	0	0	0	0	0	0	0	0	0	0	0	0	0
16062	0.00005	36,642	0	0	0	0	36,642	4,023	8,043	0	0	8,043	19,366
16063	0.0067	664,889	2,004	0	0	0	666,893	73,221	69,765	3,562	11,540	84,867	158,088

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($)						AMORTIZED TOTAL CAPITAL(a) ($/YR)	O&M COSTS ($/YR)				TOTAL ANNUAL COST ($/YR)(b)
		Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital		Equipment	Solids Handling	Monitoring	Total O&M	
16064	0.01197	885,558	2,004	0	0	0	887,562	97,450	99,486	3,931	11,540	114,957	212,406
16065	0.008	733,057	2,004	147,012	0	0	882,073	96,847	79,121	3,231	11,090	93,442	190,289
16068	0	0	0	0	0	0	0	0	0	0	0	0	0
16070	0.00133	0	0	0	0	0	0	0	0	0	0	0	0
16071	0.006	0	0	0	0	0	0	0	0	0	0	0	0
16072	0	0	0	0	0	0	0	0	0	0	0	0	0
16073	0.0182	0	0	0	0	0	0	0	0	0	0	0	0
16074	0	0	0	0	0	0	0	0	0	0	0	0	0
16075	0.01021	0	0	0	0	0	0	0	0	0	0	0	0
16076	0	0	0	0	0	0	0	0	0	0	0	0	0
16077	0.00816	0	0	0	0	0	0	0	0	0	0	0	0
16078	0.00499	0	0	0	0	0	0	0	0	0	0	0	0
16079	0.11247	2,562,809	0	512,562	0	0	3,075,371	337,659	848,079	0	11,180	859,259	1,196,918
16083	0.001	165,966	2,004	33,594	0	0	201,564	22,131	21,873	1,735	11,540	35,148	57,279
16084	0.00643	0	0	0	0	0	0	0	0	0	0	0	0
16085	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16088	0.03621	0	0	0	0	0	0	0	0	0	0	0	0
16090	0.00393	0	0	0	0	0	0	0	0	0	0	0	0
16091	0.2321	0	0	0	0	0	0	0	0	0	0	0	0
16092	0.00668	0	0	0	0	0	0	0	0	0	0	0	0
16093	0.08158	2,221,423	0	444,285	0	0	2,665,708	292,680	625,858	0	11,180	637,038	929,719
16097	0.019	1,067,839	0	213,568	0	0	1,281,407	140,692	138,700	0	10,520	149,220	289,912
16098	0	0	0	0	0	0	0	0	0	0	0	0	0
16099	0.01533	0	0	0	0	0	0	0	0	0	0	0	0
16102	0.01394	1,035,581	0	207,116	0	0	1,242,698	136,442	127,227	0	11,540	138,767	275,208
16103	0.03756	0	0	0	0	0	0	0	0	0	0	0	0
16107	0.00129	0	0	0	0	0	0	0	0	0	0	0	0
16109	0.05056	0	0	0	0	0	0	0	0	0	0	0	0
16111	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16113	0	0	0	0	0	0	0	0	0	0	0	0	0
16114	0.00864	0	0	0	0	0	0	0	0	0	0	0	0
16115	0.00407	0	0	0	0	0	0	0	0	0	0	0	0
16116	0.0042	0	0	0	0	0	0	0	0	0	0	0	0
16117	0.04	1,562,645	0	312,529	0	0	1,875,174	205,884	310,524	0	9,908	320,432	526,316
16118	0.0288	0	0	0	0	0	0	0	0	0	0	0	0
16119	0.00729	603,122	0	120,624	0	0	723,746	79,463	53,202	0	11,117	64,319	143,783
16120	0.04278	1,569,551	0	313,910	0	0	1,883,461	206,794	312,258	0	9,200	321,458	528,251
16121	0.08028	0	0	0	0	0	0	0	0	0	0	0	0
16122	0.0255	1,240,783	0	248,157	0	0	1,488,939	163,478	186,150	0	9,948	196,098	359,576
16123	0.04608	1,864,917	8,080	374,599	0	0	2,247,596	246,774	375,504	8,365	11,540	395,409	642,183

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16124	0.01666	0	0	0	0	0	0	0	0	0	0	0	0
16125	0.01419	909,456	0	181,891	0	0	1,091,347	119,824	103,609	0	10,712	114,321	234,145
16127	0.00363	423,029	2,004	85,007	0	0	510,040	56,000	38,161	2,756	11,540	52,457	108,457
16128	0.00396	0	0	0	0	0	0	0	0	0	0	0	0
16129	0.00469	444,502	0	88,900	0	0	533,403	58,565	34,237	0	11,540	45,777	104,342
16130	0.0003	36,269	0	7,254	0	0	43,523	4,779	2,190	0	11,540	13,730	18,509
16131	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16132	0.03	0	0	0	0	0	0	0	0	0	0	0	0
16135	0.01149	0	0	0	0	0	0	0	0	0	0	0	0
16137	0	0	0	0	0	0	0	0	0	0	0	0	0
16139	0.00005	0	0	0	0	0	0	0	0	0	0	0	0
16140	0	0	0	0	0	0	0	0	0	0	0	0	0
16143	0	0	0	0	0	0	0	0	0	0	0	0	0
16144	0	0	0	0	0	0	0	0	0	0	0	0	0
16146	0	0	0	0	0	0	0	0	0	0	0	0	0
16148	0.00008	0	0	0	0	0	0	0	0	0	0	0	0
16149	0	0	0	0	0	0	0	0	0	0	0	0	0
16150	0.04578	0	0	0	0	0	0	0	0	0	0	0	0
16151	0.00205	0	0	0	0	0	0	0	0	0	0	0	0
16152	0	0	0	0	0	0	0	0	0	0	0	0	0
16153	0.008	0	0	0	0	0	0	0	0	0	0	0	0
16154	0.01022	0	0	0	0	0	0	0	0	0	0	0	0
16155	0.00831	0	0	0	0	0	0	0	0	0	0	0	0
16156	0.173	0	0	0	0	0	0	0	0	0	0	0	0
16158	0.01428	0	0	0	0	0	0	0	0	0	0	0	0
16159	0.225	0	0	0	0	0	0	0	0	0	0	0	0
16160	0.00014	0	0	0	0	0	0	0	0	0	0	0	0
16161	0.053	0	0	0	0	0	0	0	0	0	0	0	0
16162	0.0009	0	0	0	0	0	0	0	0	0	0	0	0
16163	0	0	0	0	0	0	0	0	0	0	0	0	0
16164	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16165	0.03022	0	0	0	0	0	0	0	0	0	0	0	0
16166	0.00342	0	0	0	0	0	0	0	0	0	0	0	0
16169	0	0	0	0	0	0	0	0	0	0	0	0	0
16170	0.0048	507,196	2,004	101,840	0	0	611,040	67,089	44,634	4,078	11,235	59,947	127,036
16171	0.024	0	0	0	0	0	0	0	0	0	0	0	0
16173	0.025	0	0	0	0	0	0	0	0	0	0	0	0
16174	0.0072	0	0	0	0	0	0	0	0	0	0	0	0
16175	0	0	0	0	0	0	0	0	0	0	0	0	0
16176	0.03727	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

		CAPITAL COSTS ($)						AMORTIZED	O & M COSTS ($/YR)				TOTAL
ID#	Flow (MGD)	Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	TOTAL CAPITAL(a) ($/YR)	Equipment	Solids Handling	Monitoring	Total O & M	ANNUAL COST ($/YR)(b)
16177	0	0	0	0	0	0	0	0	0	0	0	0	0
16180	0	0	0	0	0	0	0	0	0	0	0	0	0
16184	0	0	0	0	0	0	0	0	0	0	0	0	0
16185	0	0	0	0	0	0	0	0	0	0	0	0	0
16186	0.00304	0	0	0	0	0	0	0	0	0	0	0	0
16187	0.003	0	0	0	0	0	0	0	0	0	0	0	0
16189	0	0	0	0	0	0	0	0	0	0	0	0	0
16190	0	0	0	0	0	0	0	0	0	0	0	0	0
16191	0	0	0	0	0	0	0	0	0	0	0	0	0
16193	0.0023	0	0	0	0	0	0	0	0	0	0	0	0
16196	0.01223	965,897	11,645	0	0	0	977,542	107,329	115,547	10,115	11,540	137,202	244,531
16197	0	0	0	0	0	0	0	0	0	0	0	0	0
16199	0.0008	0	0	0	0	0	0	0	0	0	0	0	0
16200	0.01142	0	0	0	0	0	0	0	0	0	0	0	0
16201	0.00188	0	0	0	0	0	0	0	0	0	0	0	0
16202	0.01301	0	0	0	0	0	0	0	0	0	0	0	0
16203	0.02	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16204	0	0	0	0	0	0	0	0	0	0	0	0	0
16205	0	0	0	0	0	0	0	0	0	0	0	0	0
16206	0.05739	0	0	0	0	0	0	0	0	0	0	0	0
16208	0.00334	0	0	0	0	0	0	0	0	0	0	0	0
16211	0.15	0	0	0	0	0	0	0	0	0	0	0	0
16212	0.0007	134,753	2,004	0	0	0	136,757	15,015	20,233	1,516	10,500	32,249	47,264
16215	0	0	0	0	0	0	0	0	0	0	0	0	0
16217	0	0	0	0	0	0	0	0	0	0	0	0	0
16219	0.02544	0	0	0	0	0	0	0	0	0	0	0	0
16220	0.03041	0	0	0	0	0	0	0	0	0	0	0	0
16221	0.00662	0	0	0	0	0	0	0	0	0	0	0	0
16222	0.01548	0	0	0	0	0	0	0	0	0	0	0	0
16222	0	0	0	0	0	0	0	0	0	0	0	0	0
16223	0.02904	1,531,517	7,768	0	0	0	1,539,285	169,005	246,811	8,212	10,500	265,523	434,528
16224	0	0	0	0	0	0	0	0	0	0	0	0	0
16225	0.031	0	0	0	0	0	0	0	0	0	0	0	0
16228	0.00072	0	0	0	0	0	0	0	0	0	0	0	0
16230	0	0	0	0	0	0	0	0	0	0	0	0	0
16231	0	0	0	0	0	0	0	0	0	0	0	0	0
16232	0	0	0	0	0	0	0	0	0	0	0	0	0
16233	0.0097	840,751	9,868	0	0	0	850,619	93,393	95,062	9,277	11,540	115,879	209,272
16234	0.03083	0	0	0	0	0	0	0	0	0	0	0	0

Table 9-13: BAT Option III Subtitle D Non-Hazardous Subcategory (continued)

ID#	Flow (MGD)	CAPITAL COSTS ($) Equipment	Sludge Handling	Retrofit	Permit Modification	Land	Total Capital	AMORTIZED TOTAL CAPITAL(a) ($/YR)	O&M COSTS ($/YR) Equipment	Solids Handling	Monitoring	Total O&M	TOTAL ANNUAL COST ($/YR)(b)
16236	0.00595	0	0	0	0	0	0	0	0	0	0	0	0
16239	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0	0	0	0	0	0	0	0	0	0	0	0	0
16240	0.0056	0	0	0	0	0	0	0	0	0	0	0	0
16241	0	0	0	0	0	0	0	0	0	0	0	0	0
16242	0.0005	0	0	0	0	0	0	0	0	0	0	0	0
16243	0	0	0	0	0	0	0	0	0	0	0	0	0
16245	0	0	0	0	0	0	0	0	0	0	0	0	0
16246	0.00135	0	0	0	0	0	0	0	0	0	0	0	0
16248	0.01	0	0	0	0	0	0	0	0	0	0	0	0
16249	0	0	0	0	0	0	0	0	0	0	0	0	0
16250	0.0002	0	0	0	0	0	0	0	0	0	0	0	0
16251	0.0007	0	0	0	0	0	0	0	0	0	0	0	0
16252	0.005	0	0	0	0	0	0	0	0	0	0	0	0
16253	0.01776	1,056,810	0	211,362	0	0	1,268,173	139,239	143,068	0	11,068	154,136	293,374
TOTALS	2.694	29,860,948	76,992	4,580,148	0	0	34,518,089	3,789,901	5,442,636	85,588	368,307	5,896,531	9,695,630

(a) Amortization assuming 7% interest over 15 year period.

(b) Off-site disposal costs used for low flow facilities 16048, 16055, and 16062

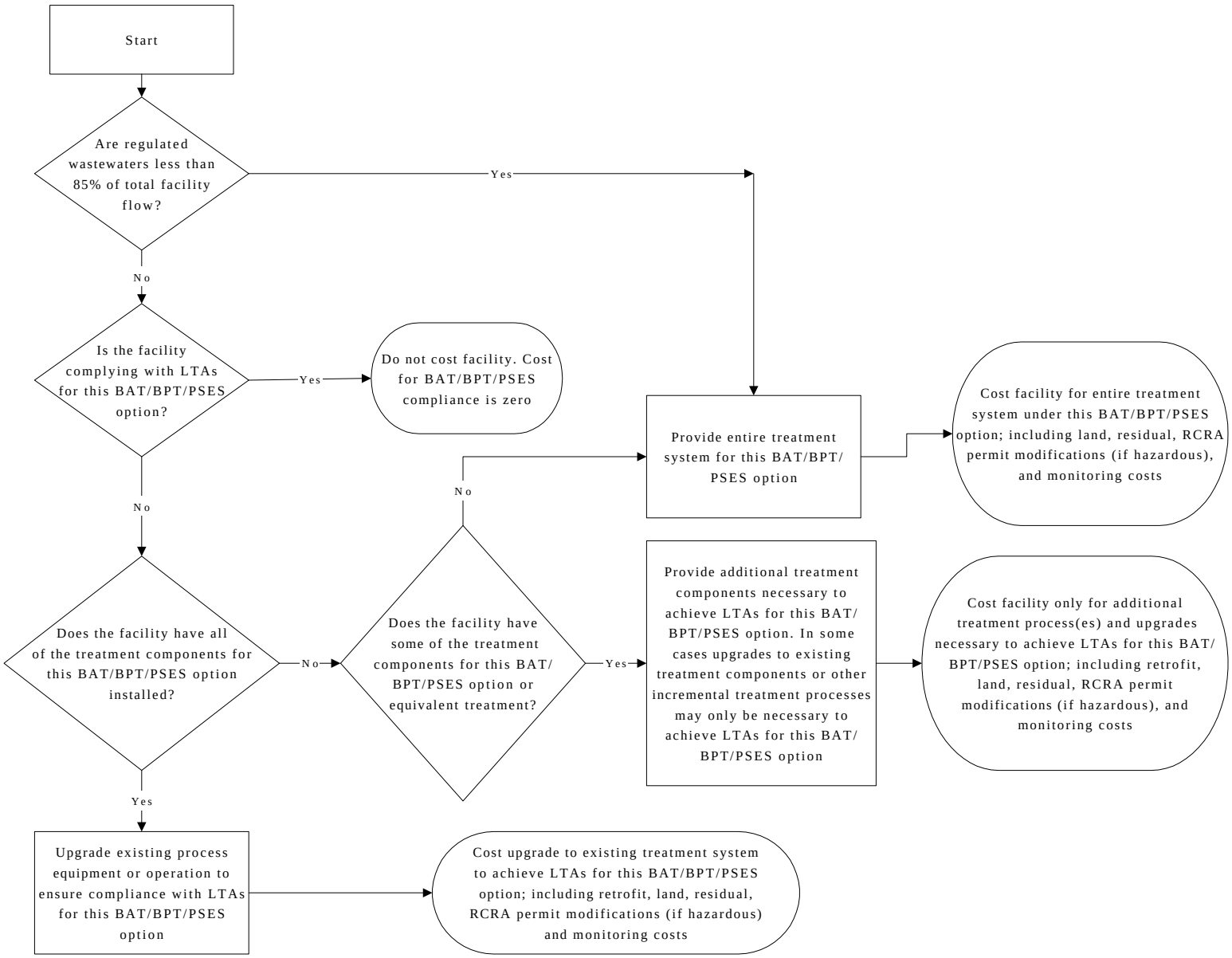


Figure 9-1: Option-Specific Costing Logic Flow Diagram

Figure 9-2
Equalization Capital Cost Curve

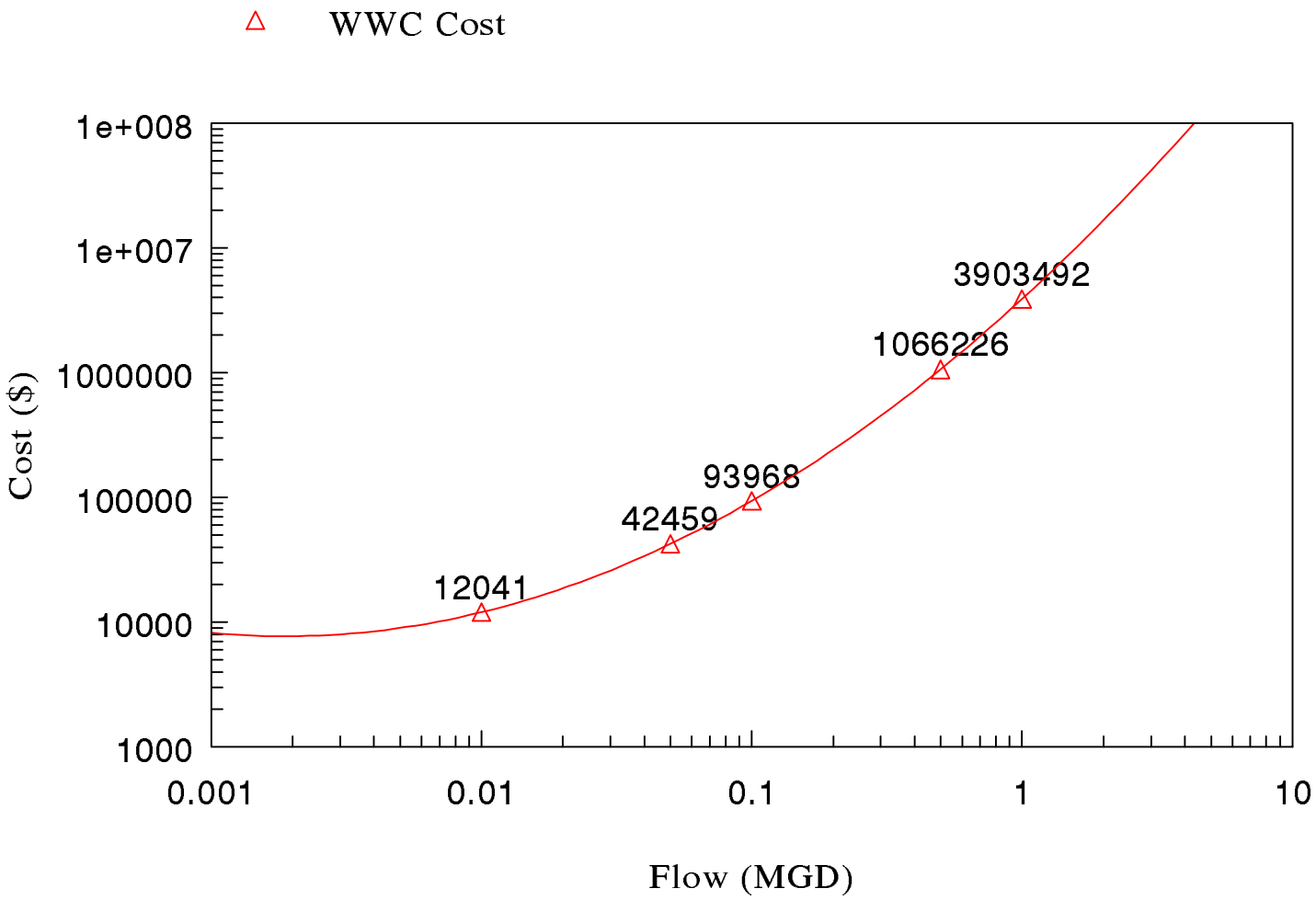


Figure 9-3
Flocculation Capital Cost Curve

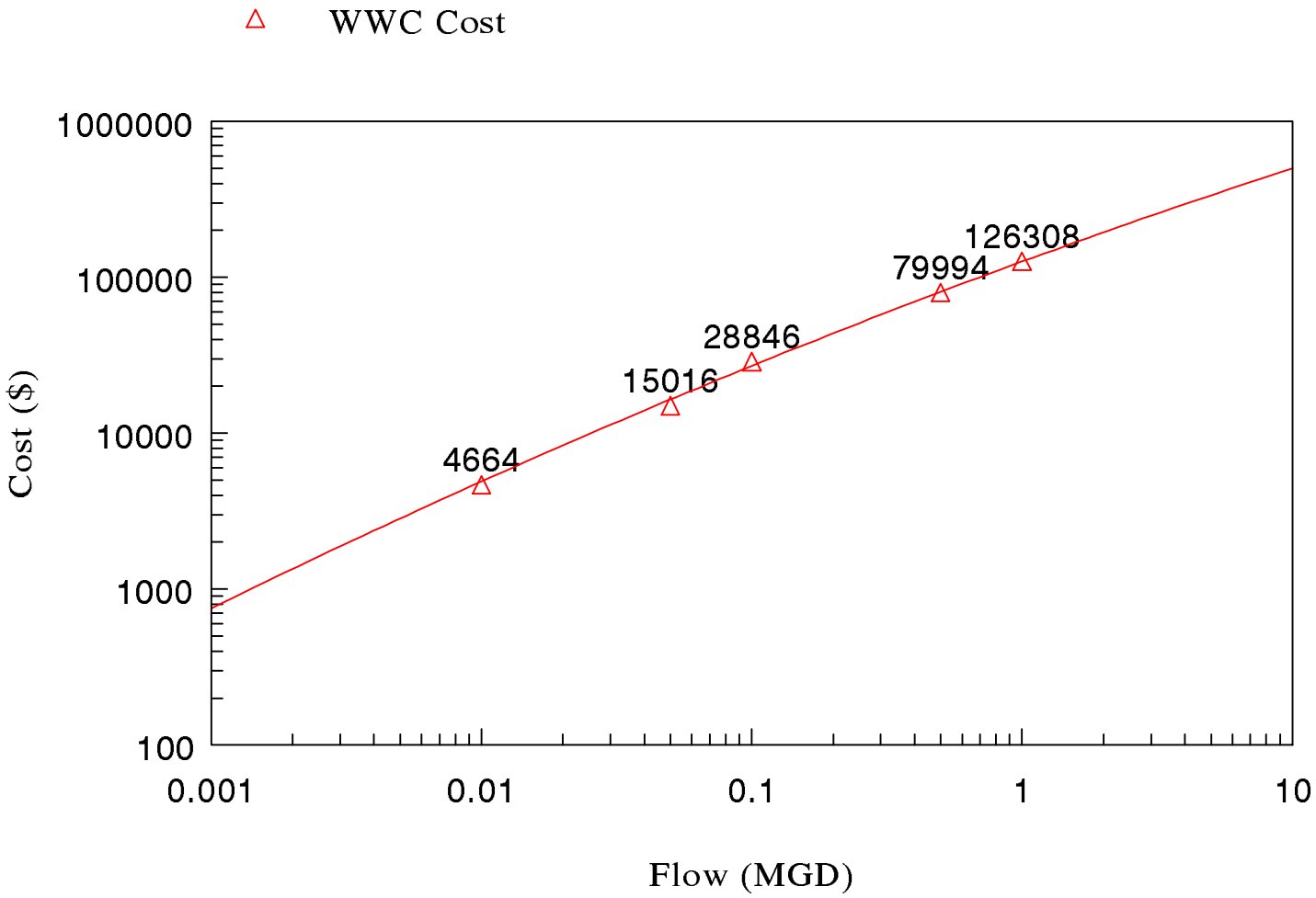


Figure 9-4
Flocculation O&M Cost Curve

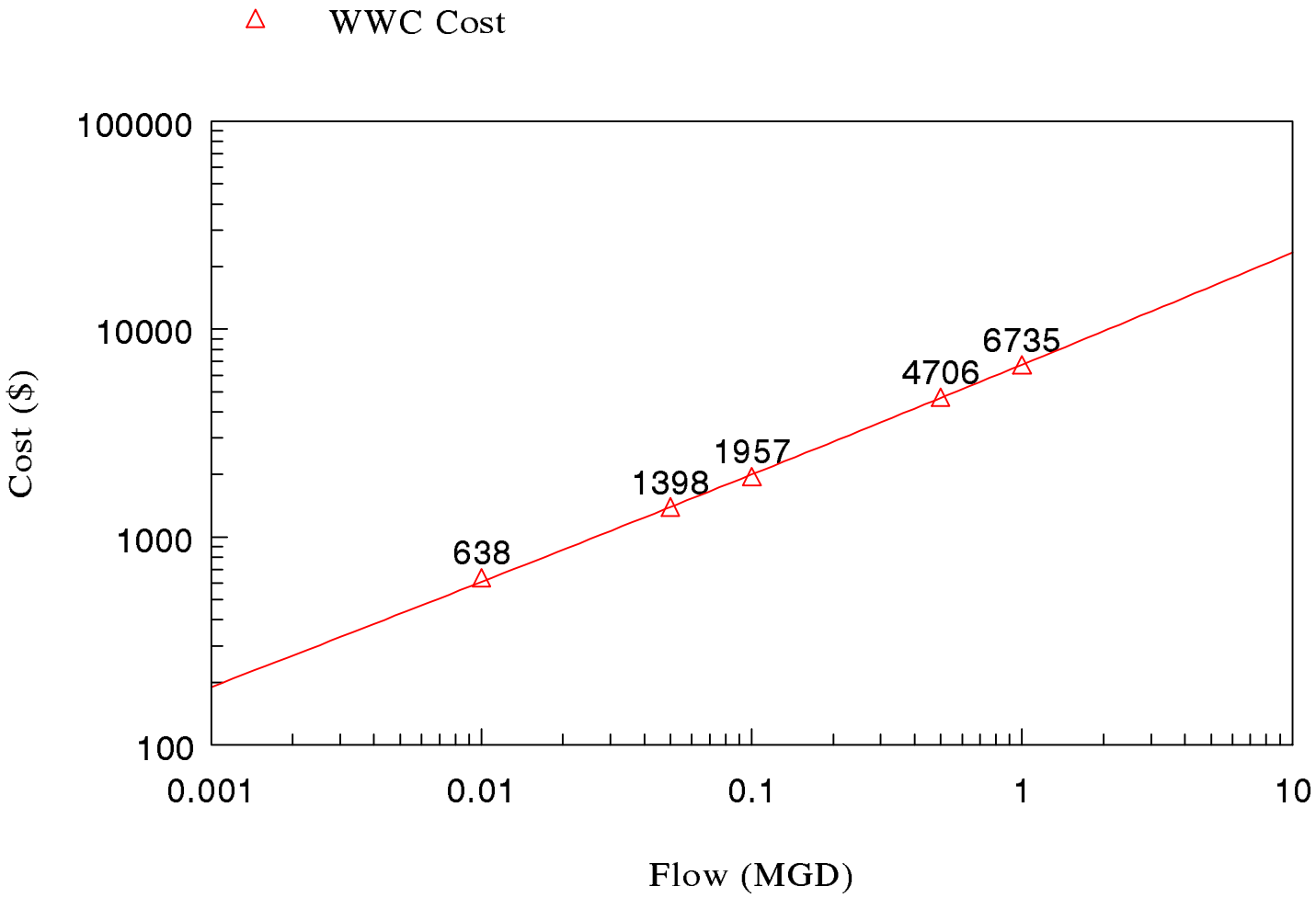


Figure 9-5
Sodium Hydroxide Capital Cost Curve

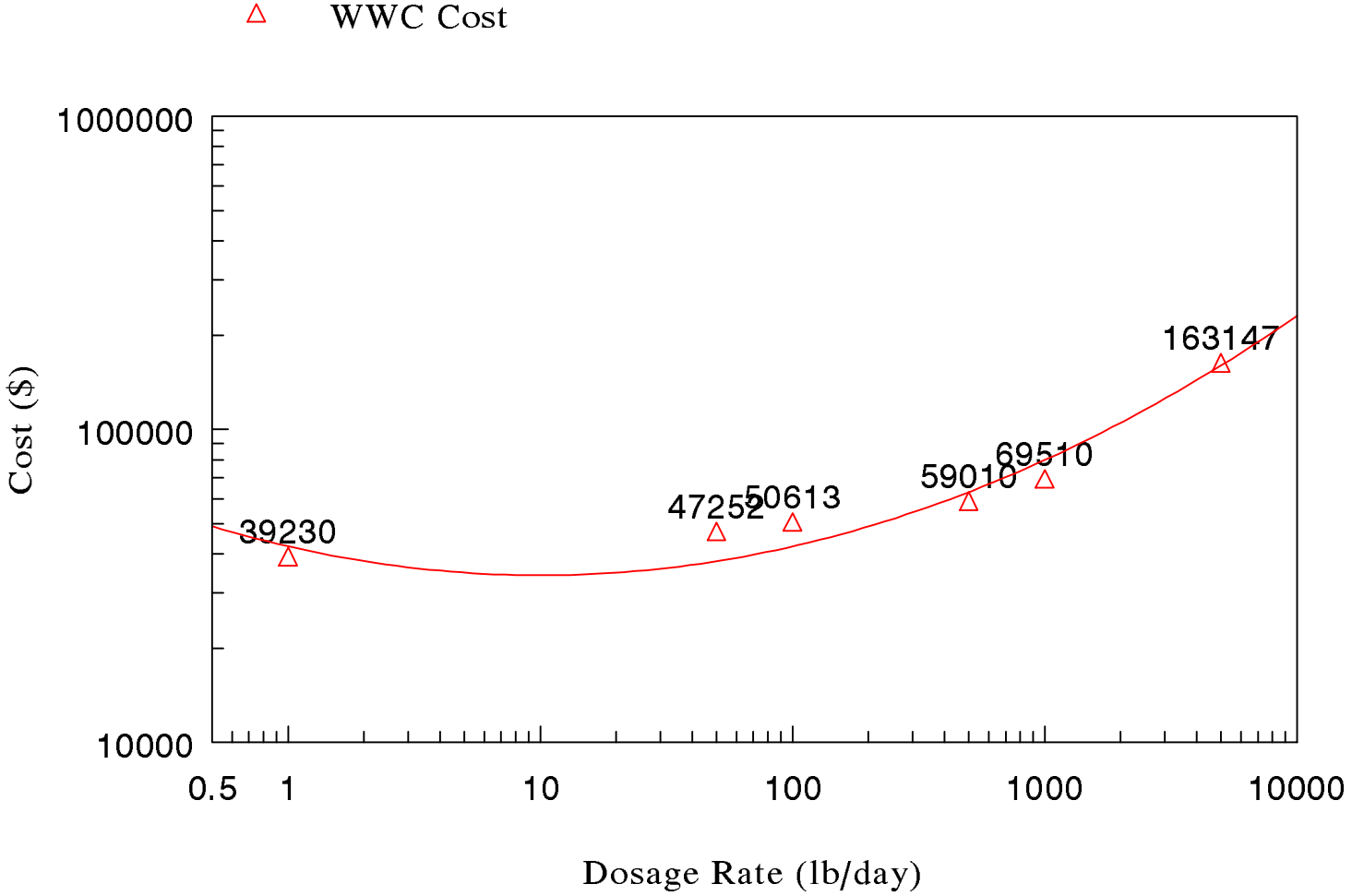


Figure 9-6
Sodium Hydroxide O&M Cost Curve

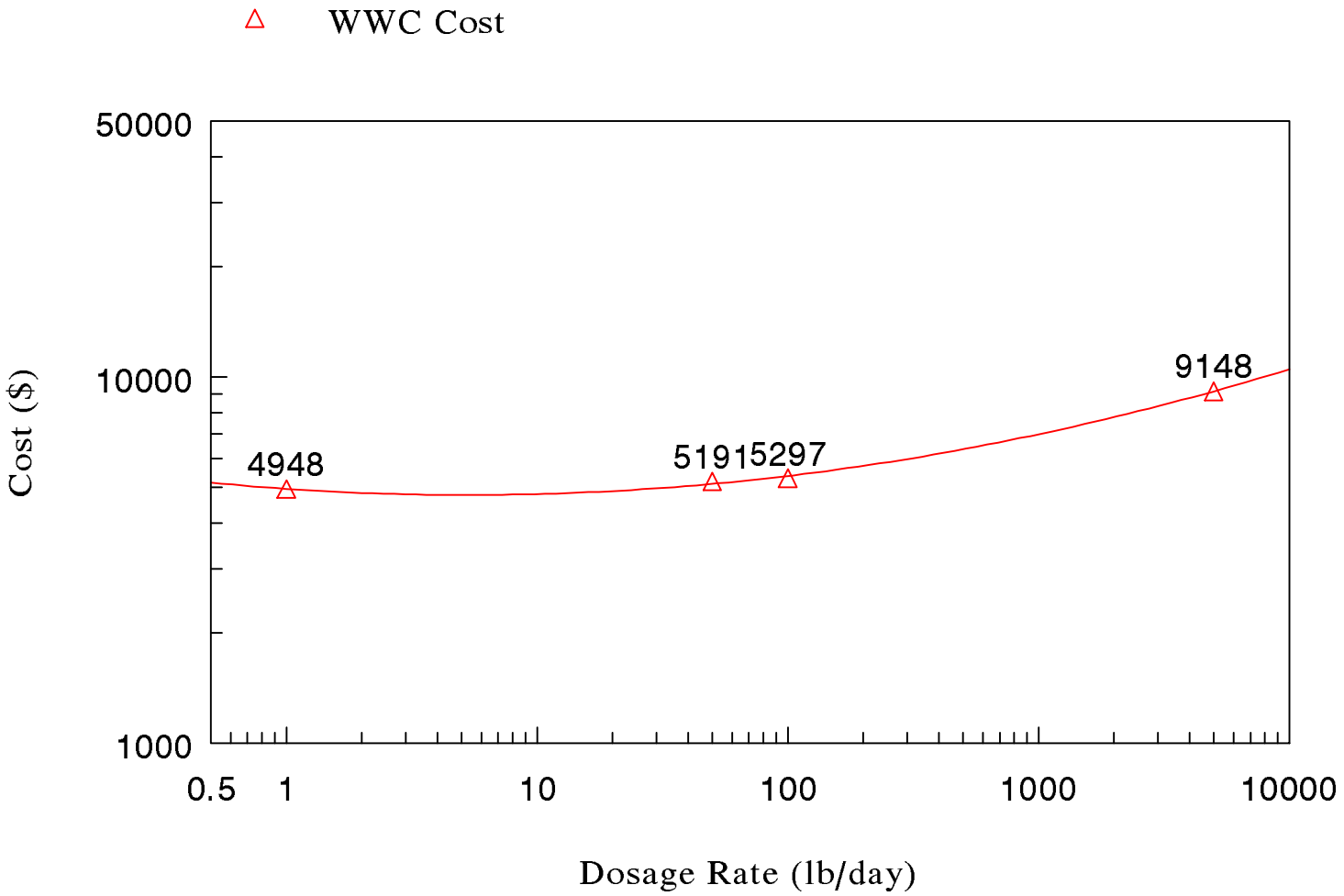


Figure 9-7
Phosphoric Acid Feed Capital Cost Curve

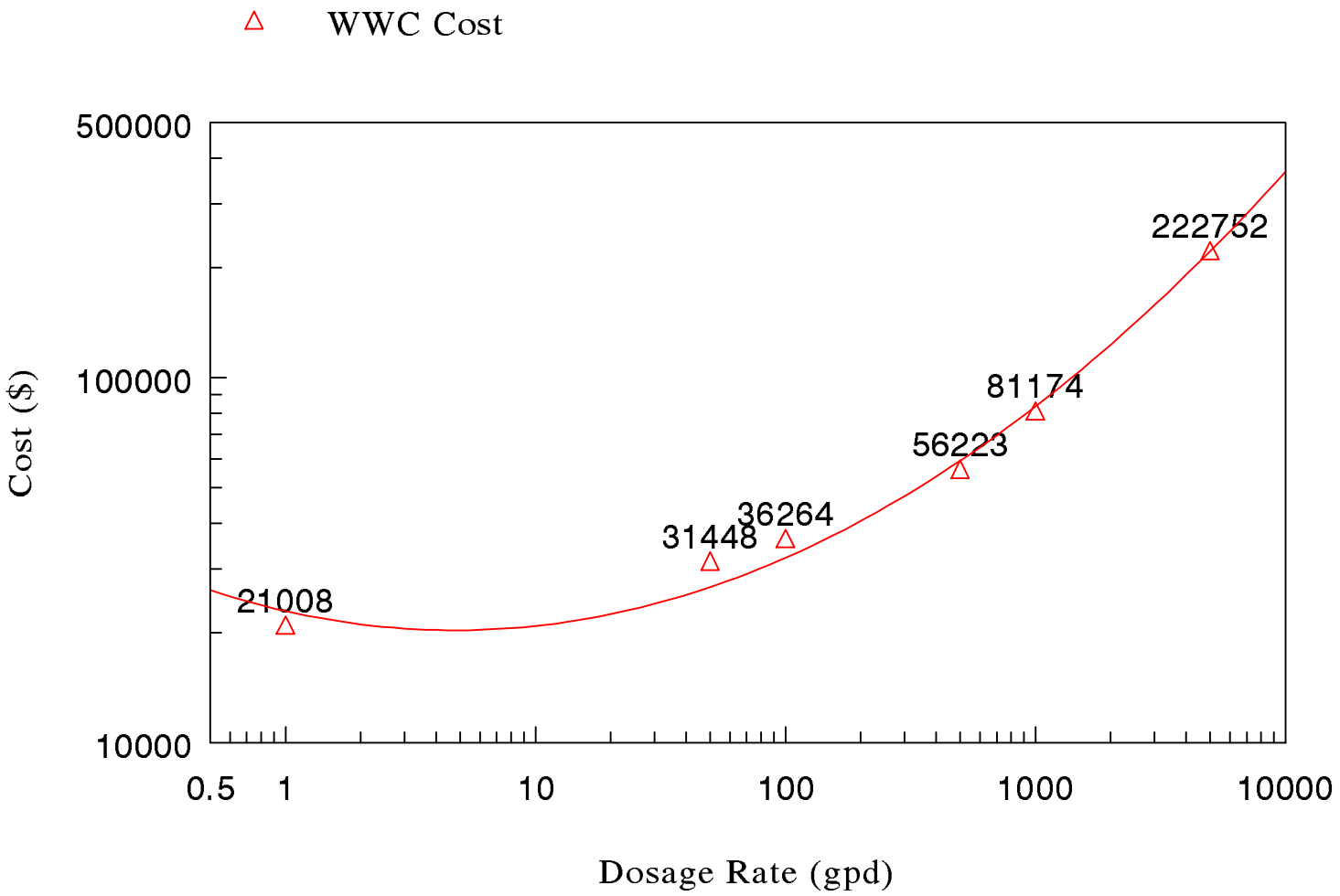


Figure 9-8
Phosphoric Acid Feed O&M Cost Curve

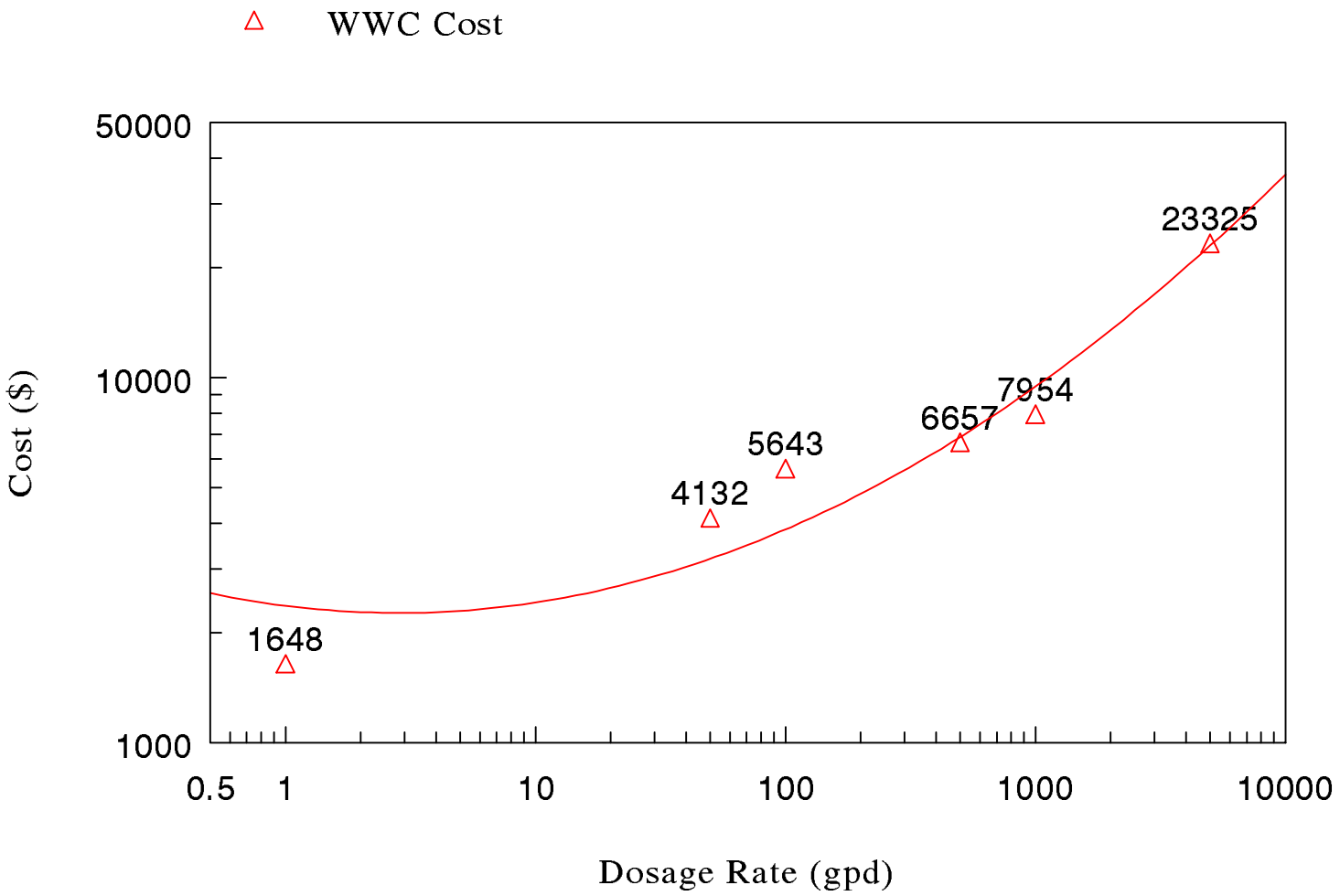


Figure 9-9
Polymer Feed Capital Cost Curve

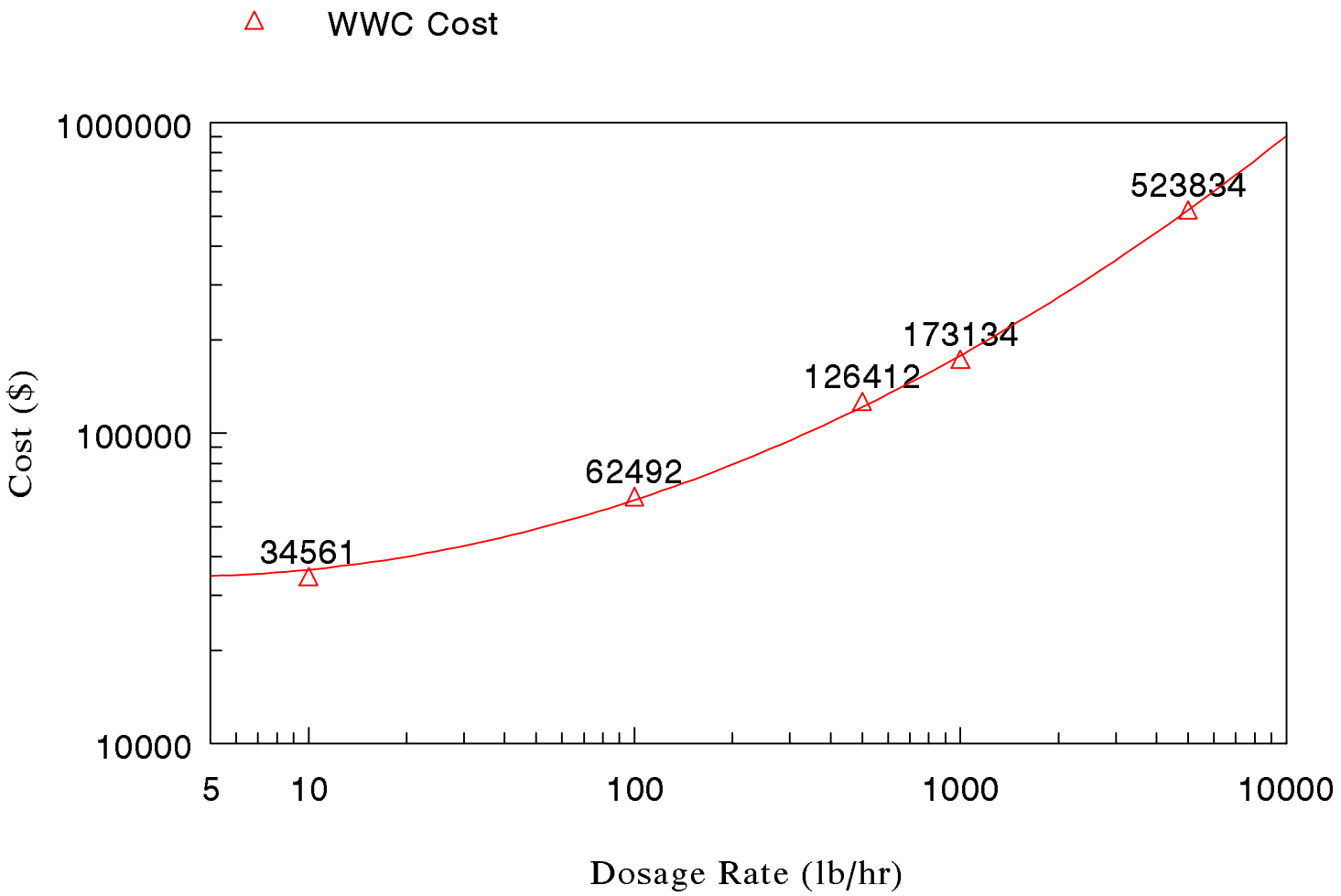


Figure 9-10
Polymer Feed O&M Cost Curve

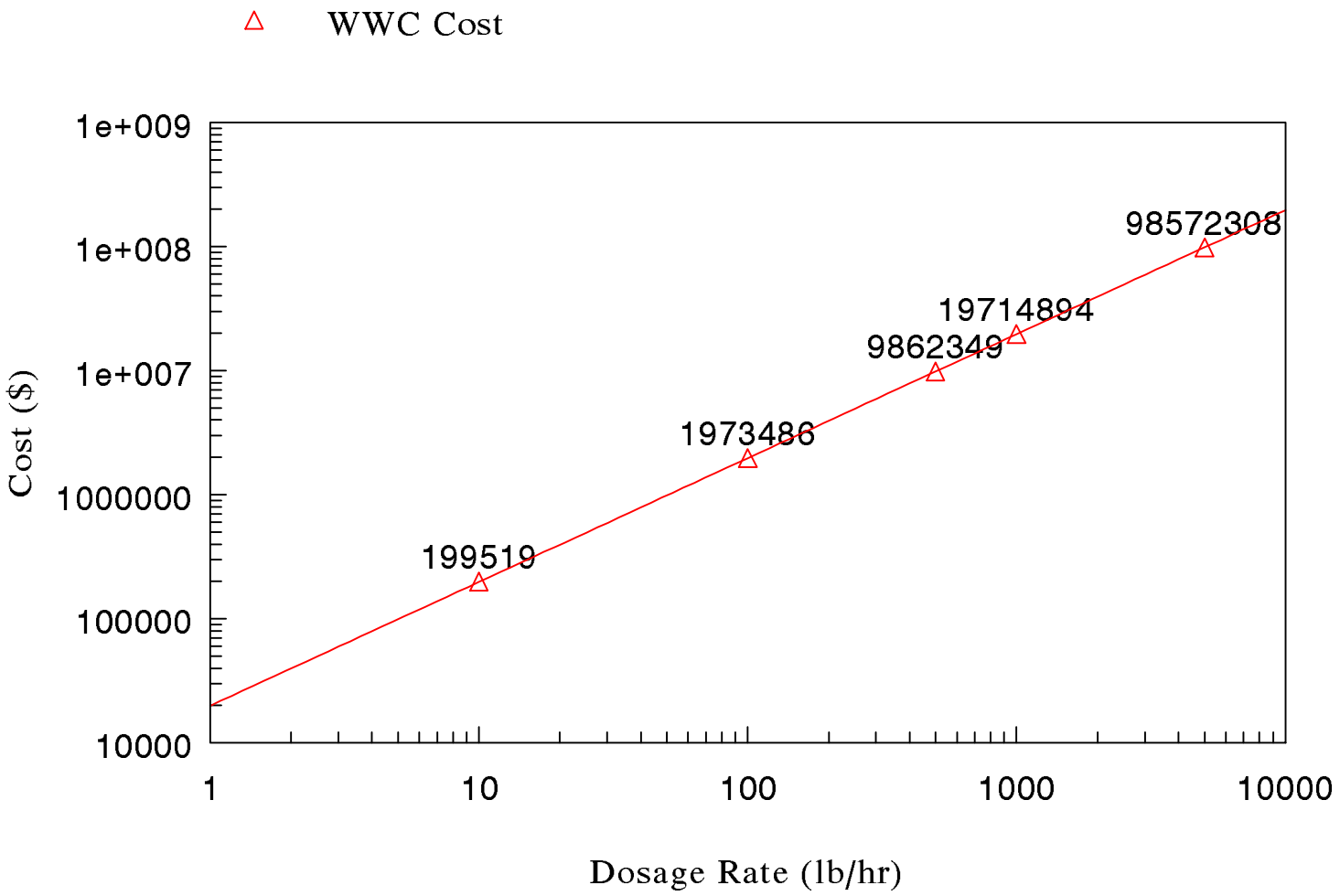


Figure 9-11
Primary Clarifier Capital Cost Curve

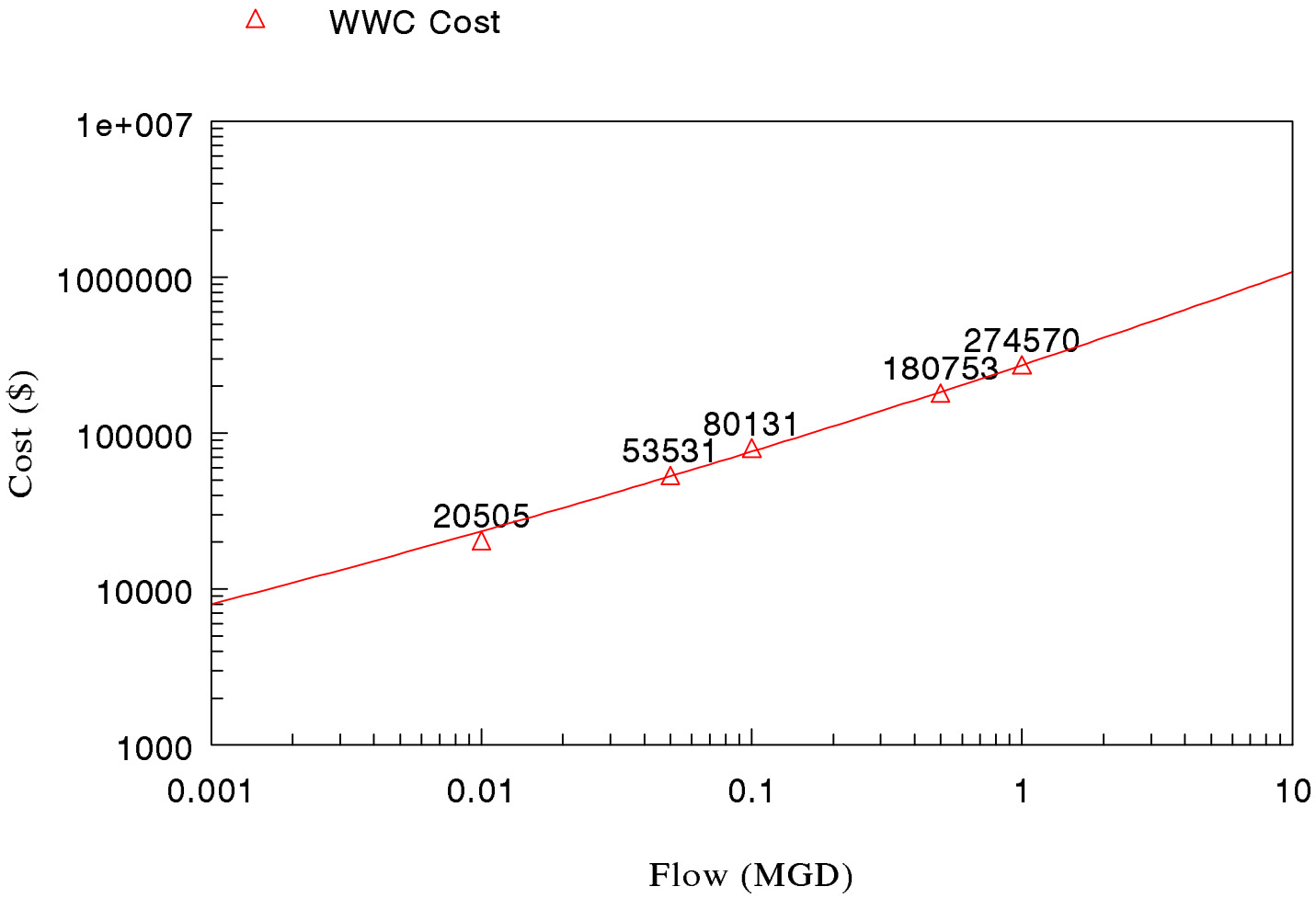


Figure 9-12
Primary Clarifier O&M Cost Curve

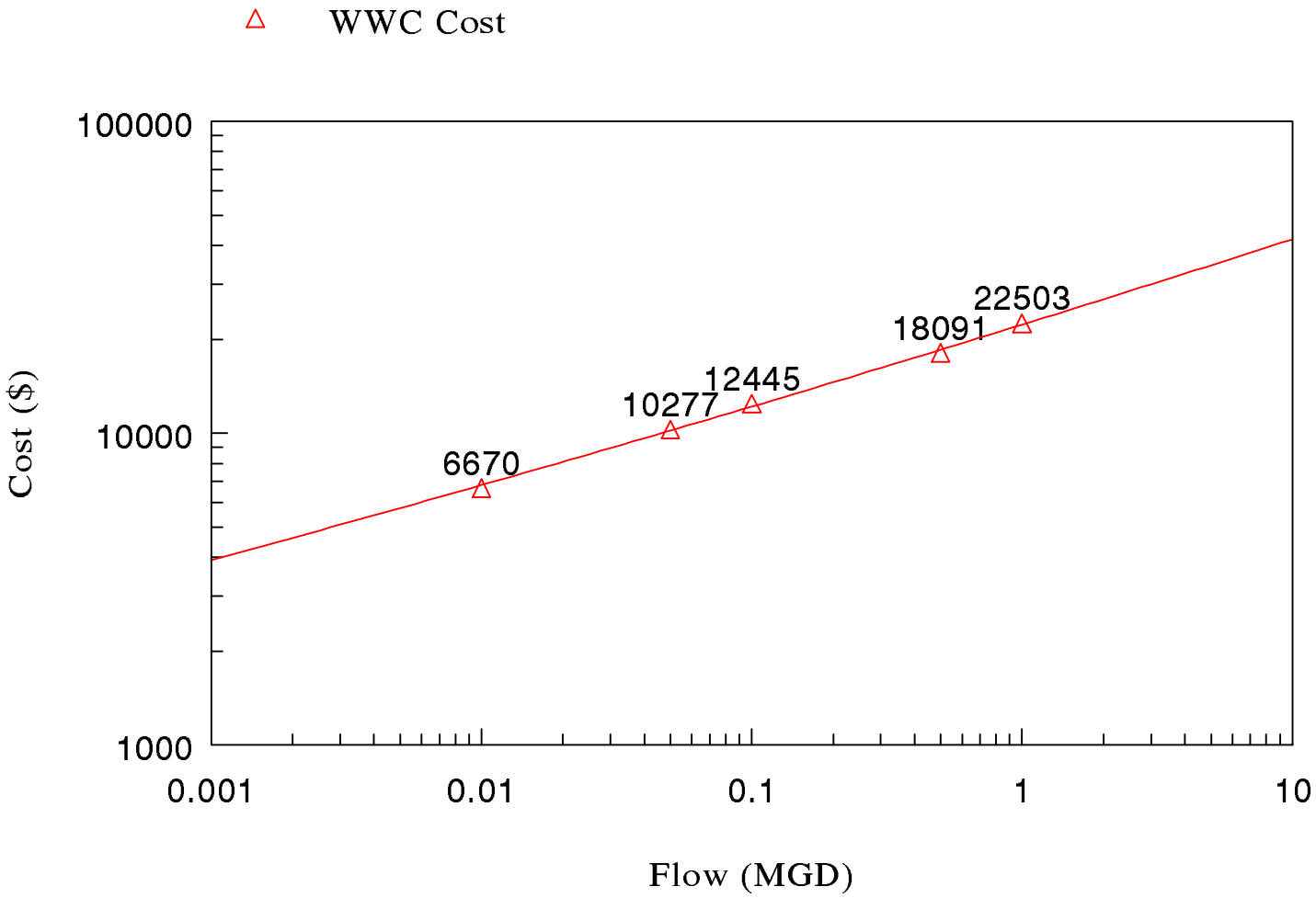


Figure 9-13
Aeration Basin Capital Cost Curve

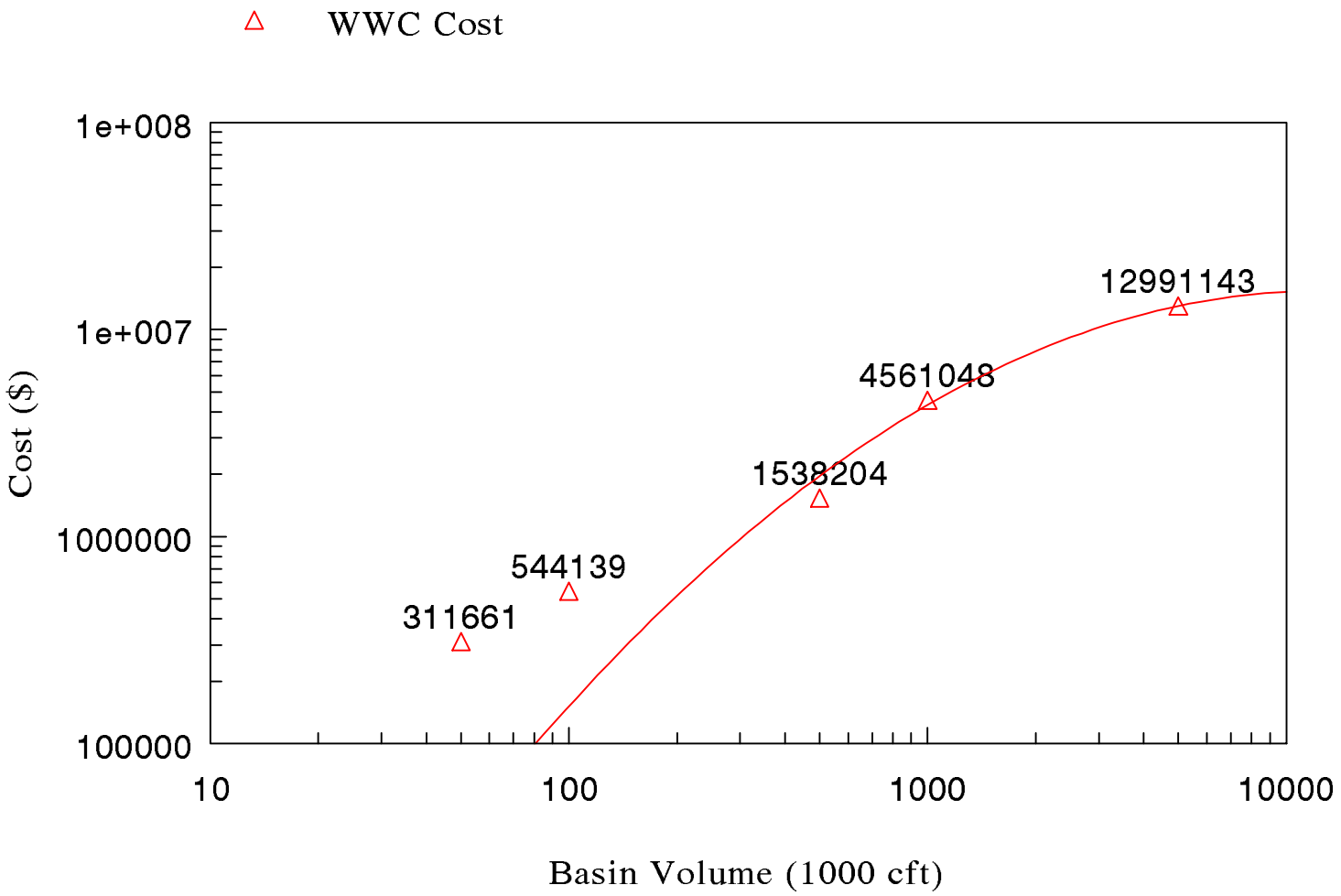


Figure 9-14
Air Diffusion System Capital Cost Curve

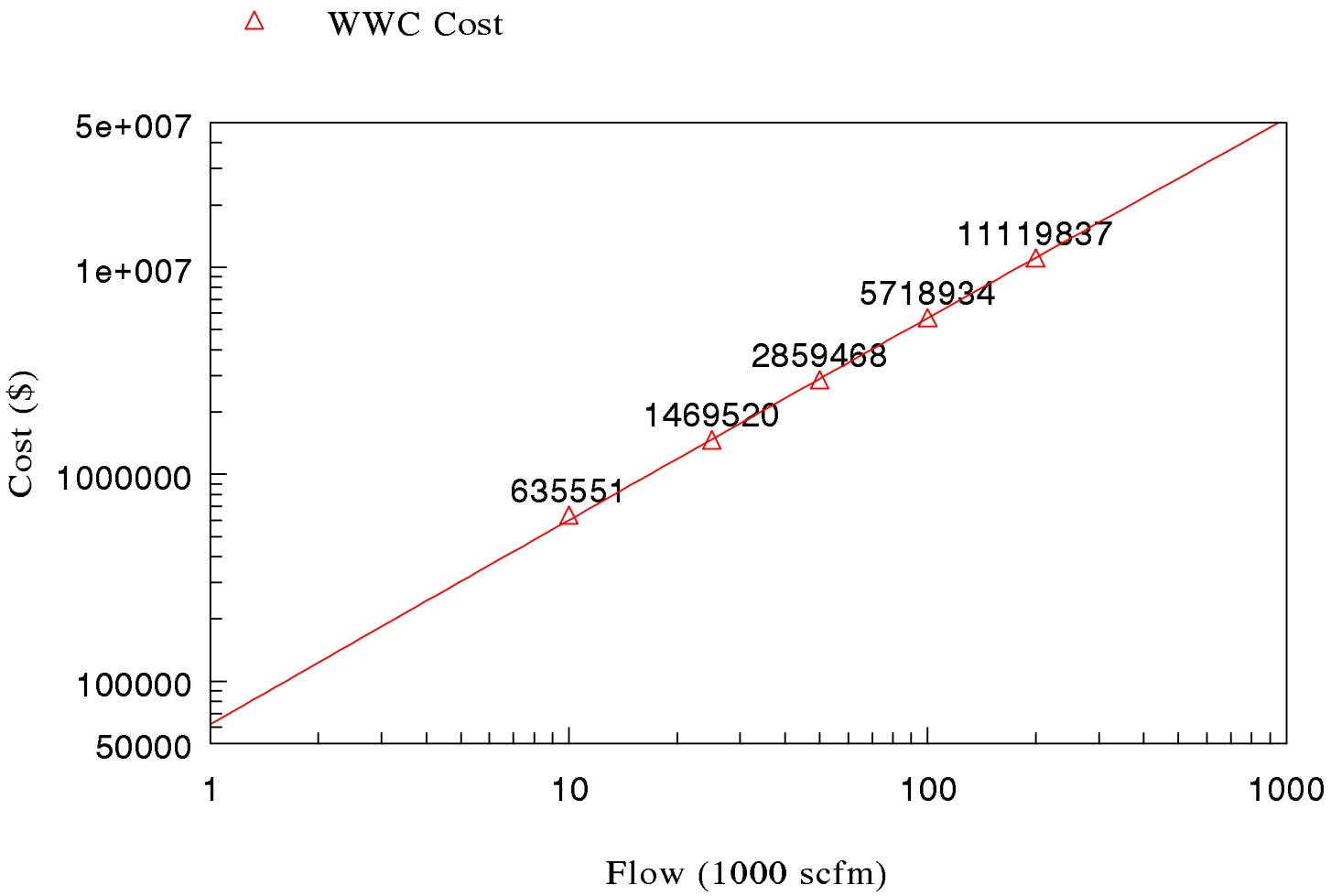


Figure 9-15
Air Diffusion System O&M Cost Curve

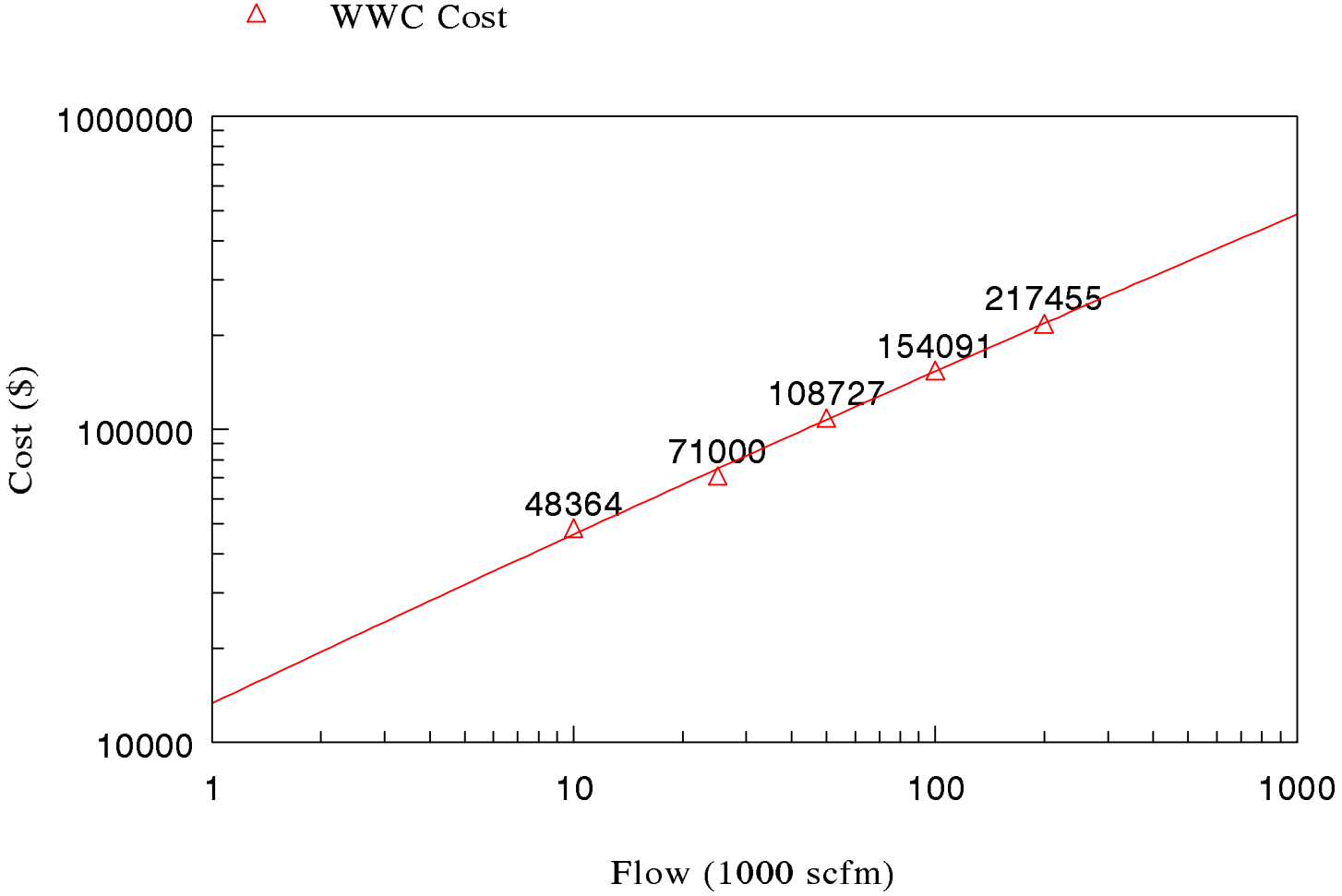


Figure 9-16
Secondary Clarifier Capital Cost Curve

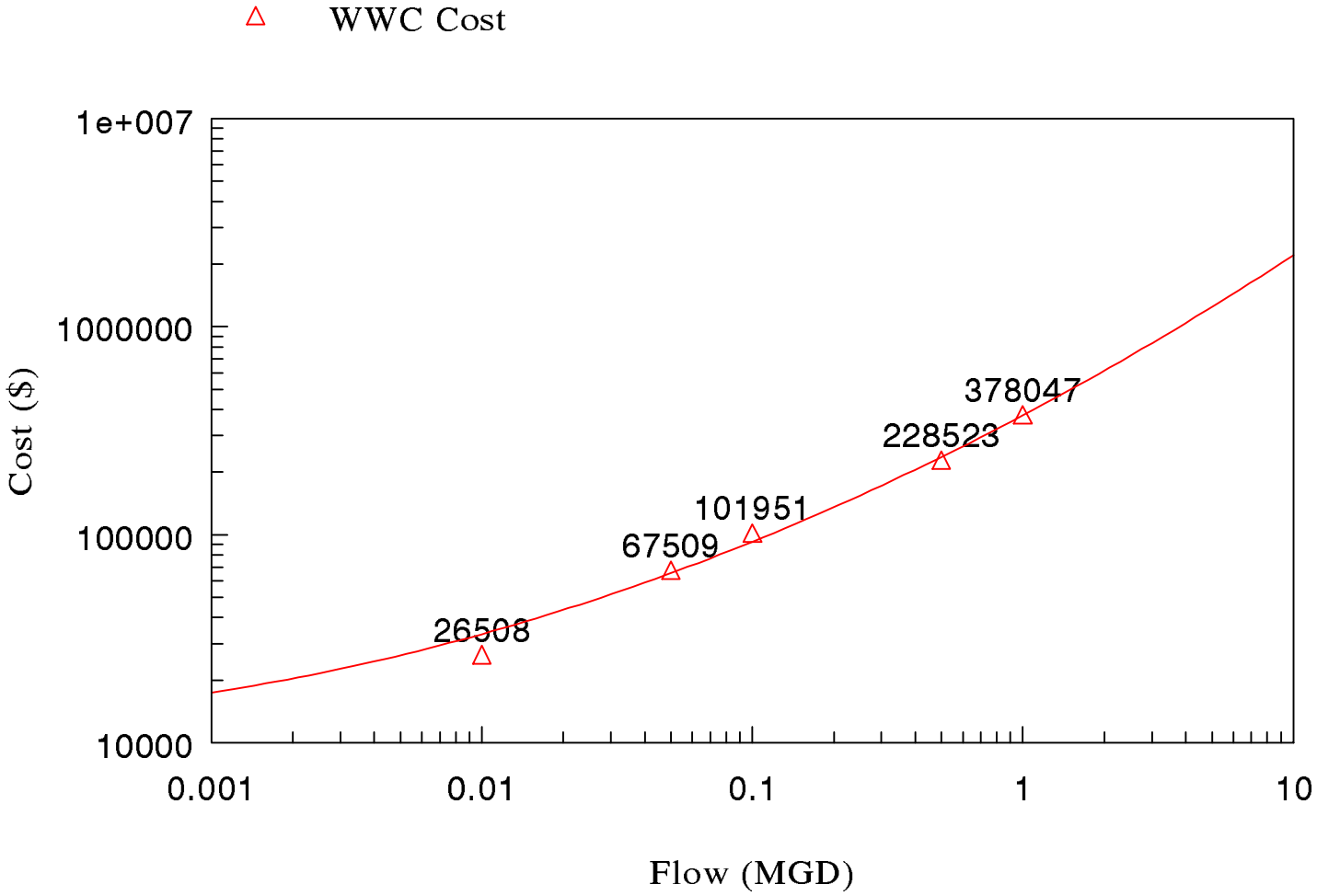


Figure 9-17
Secondary Clarifier O&M Cost Curve

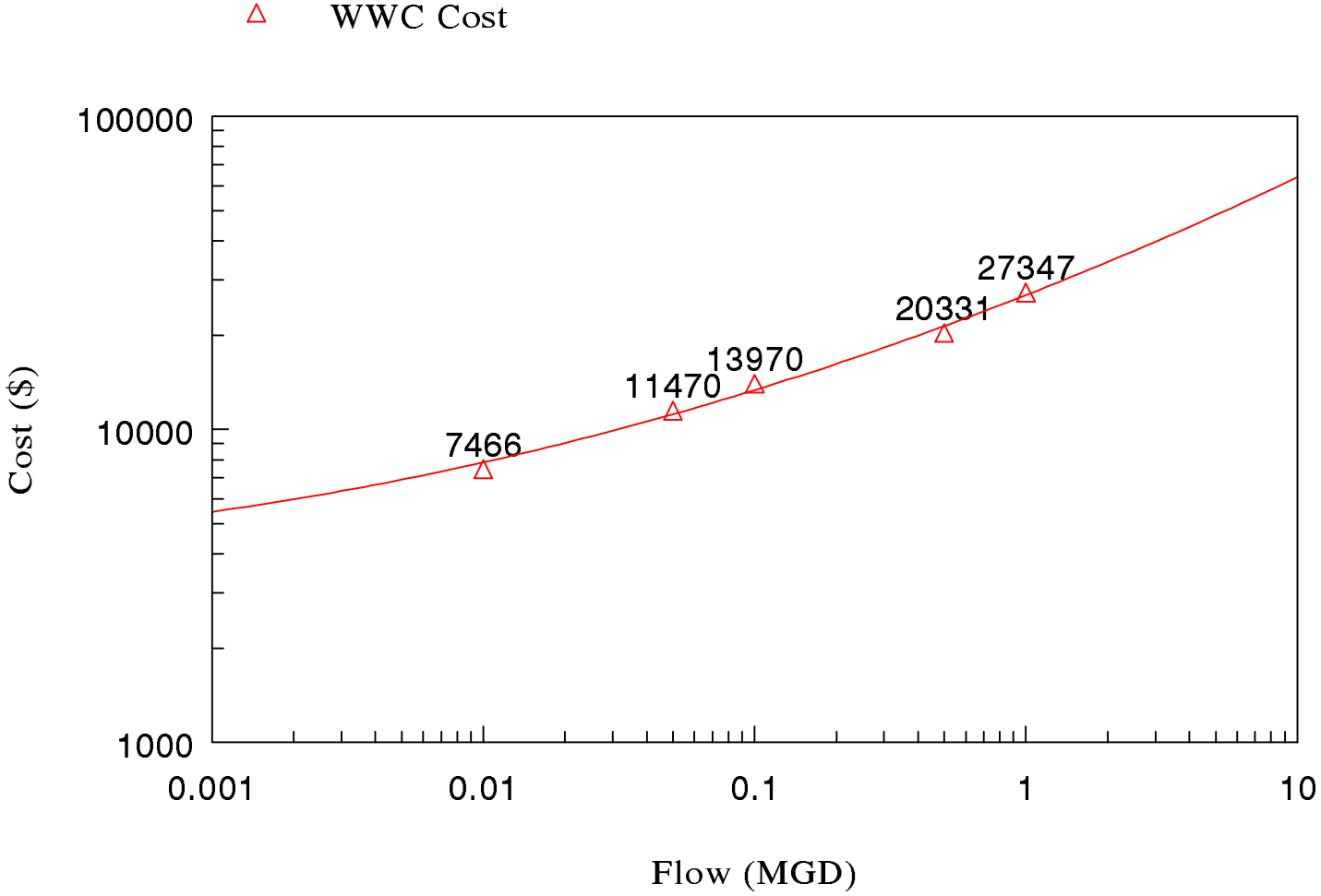


Figure 9-18
Multimedia Filtration Capital Cost Curve

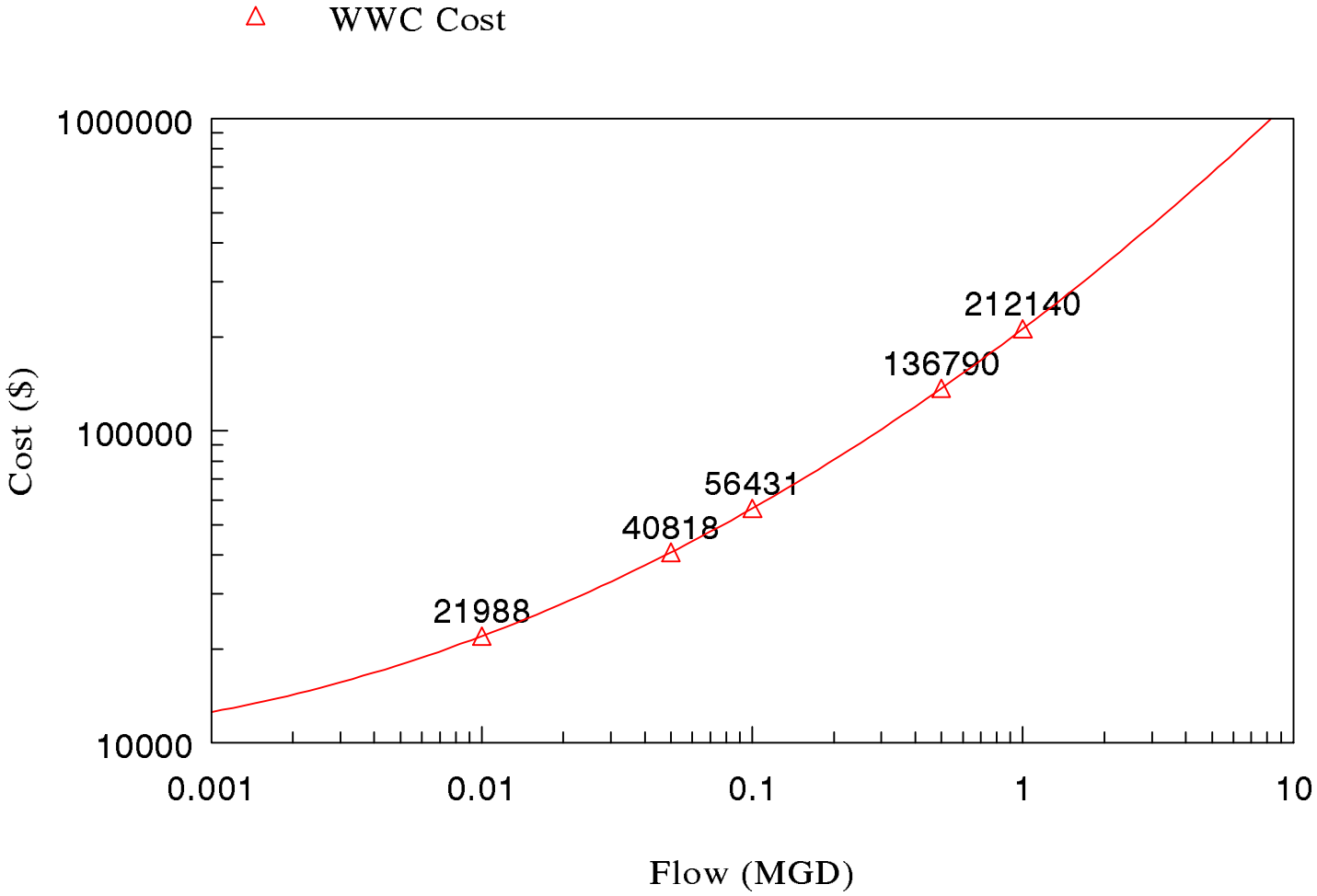


Figure 9-19
Multimedia Filtration O&M Cost Curve

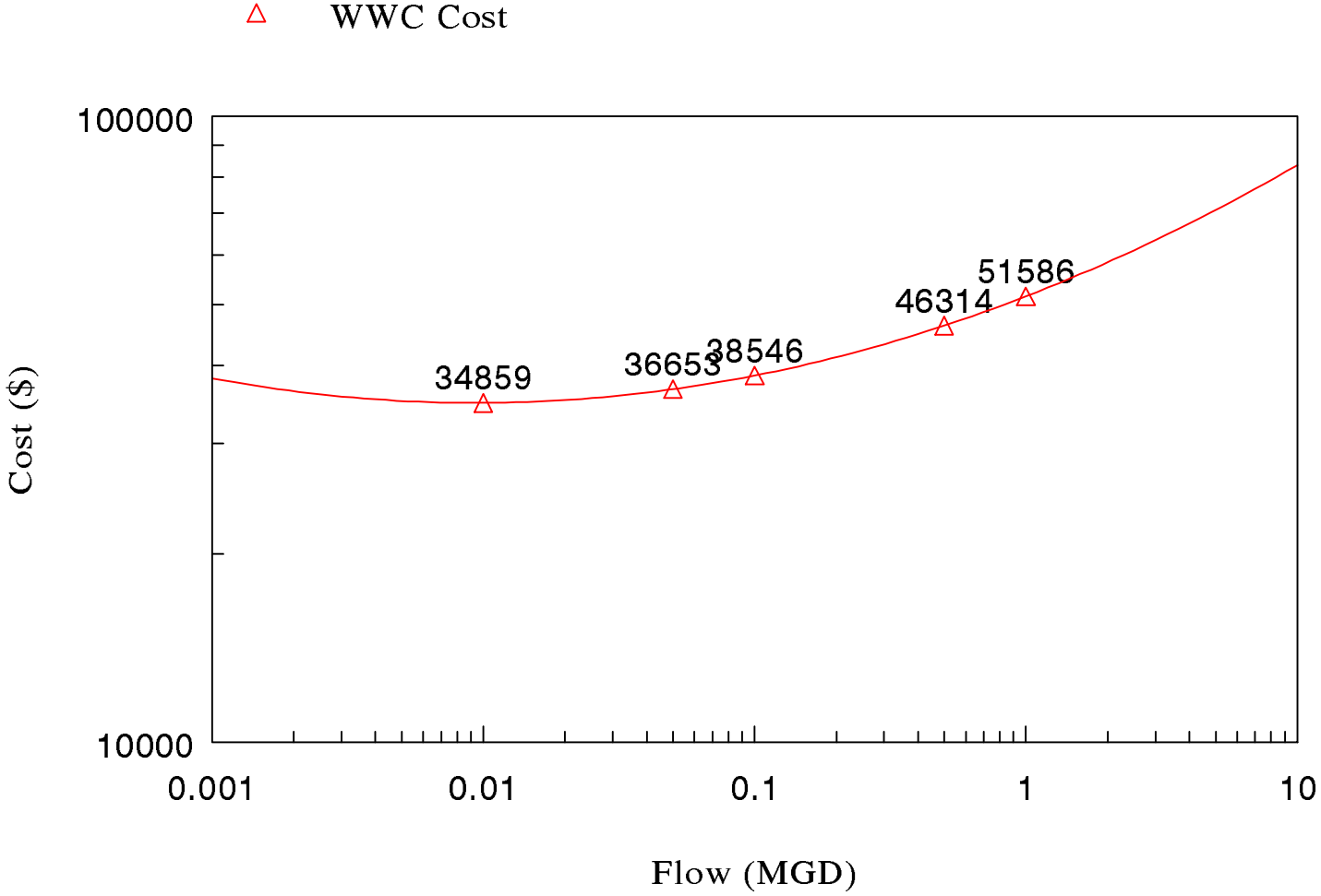


Figure 9-20
Reverse Osmosis Capital Cost Curve

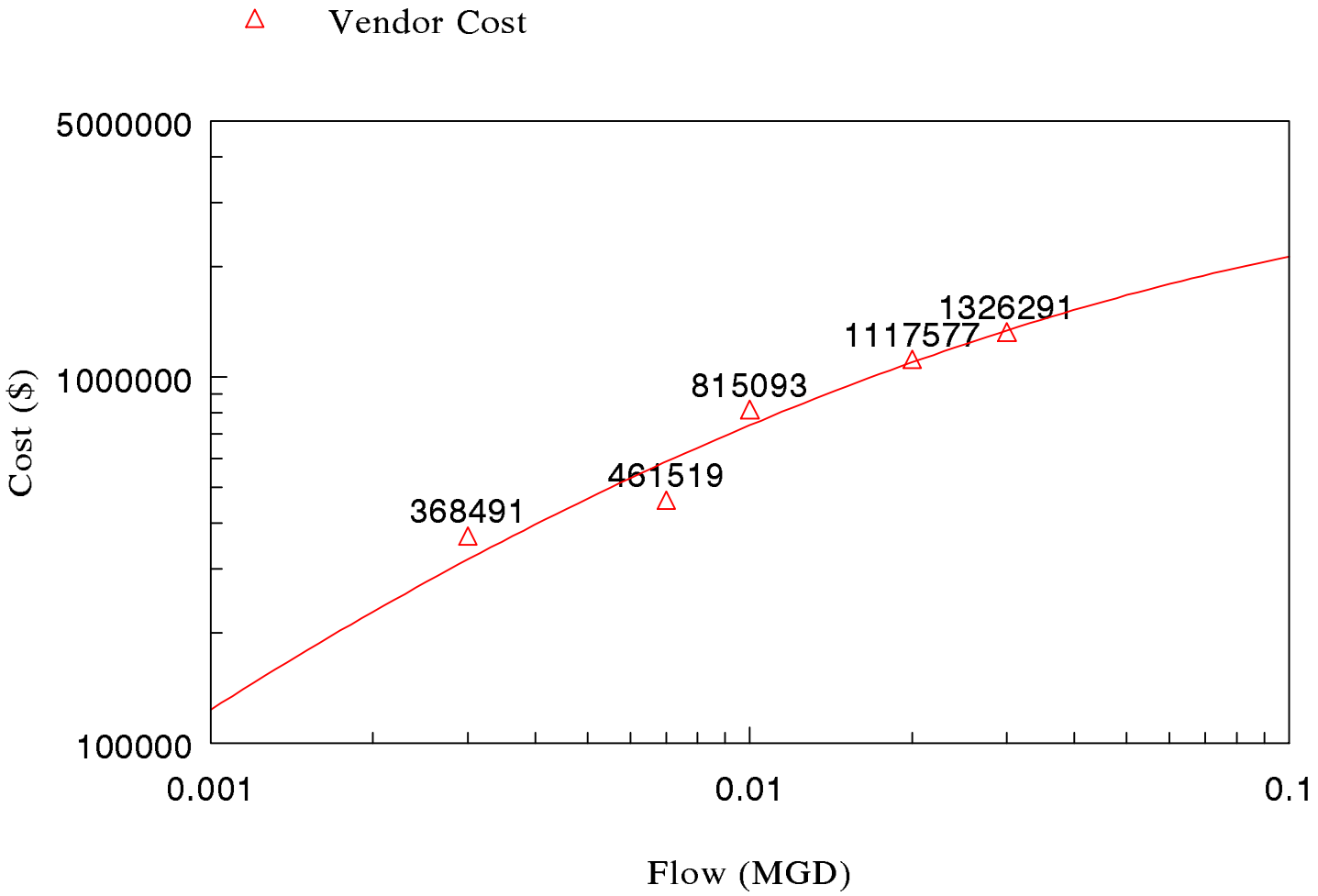


Figure 9-21
Sludge Drying Beds Capital Cost Curve

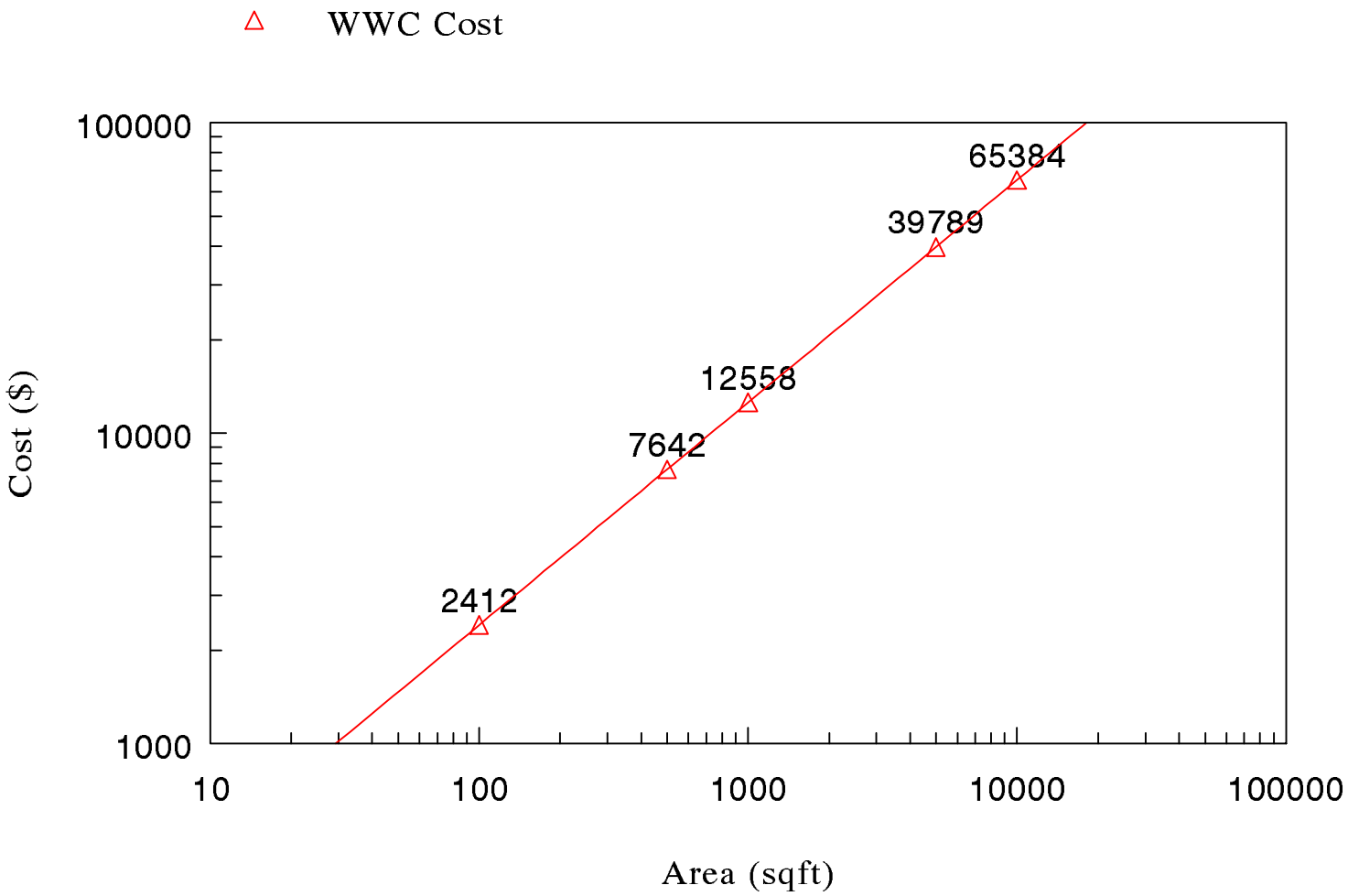


Figure 9-22
Sludge Drying Beds O&M Cost Curve

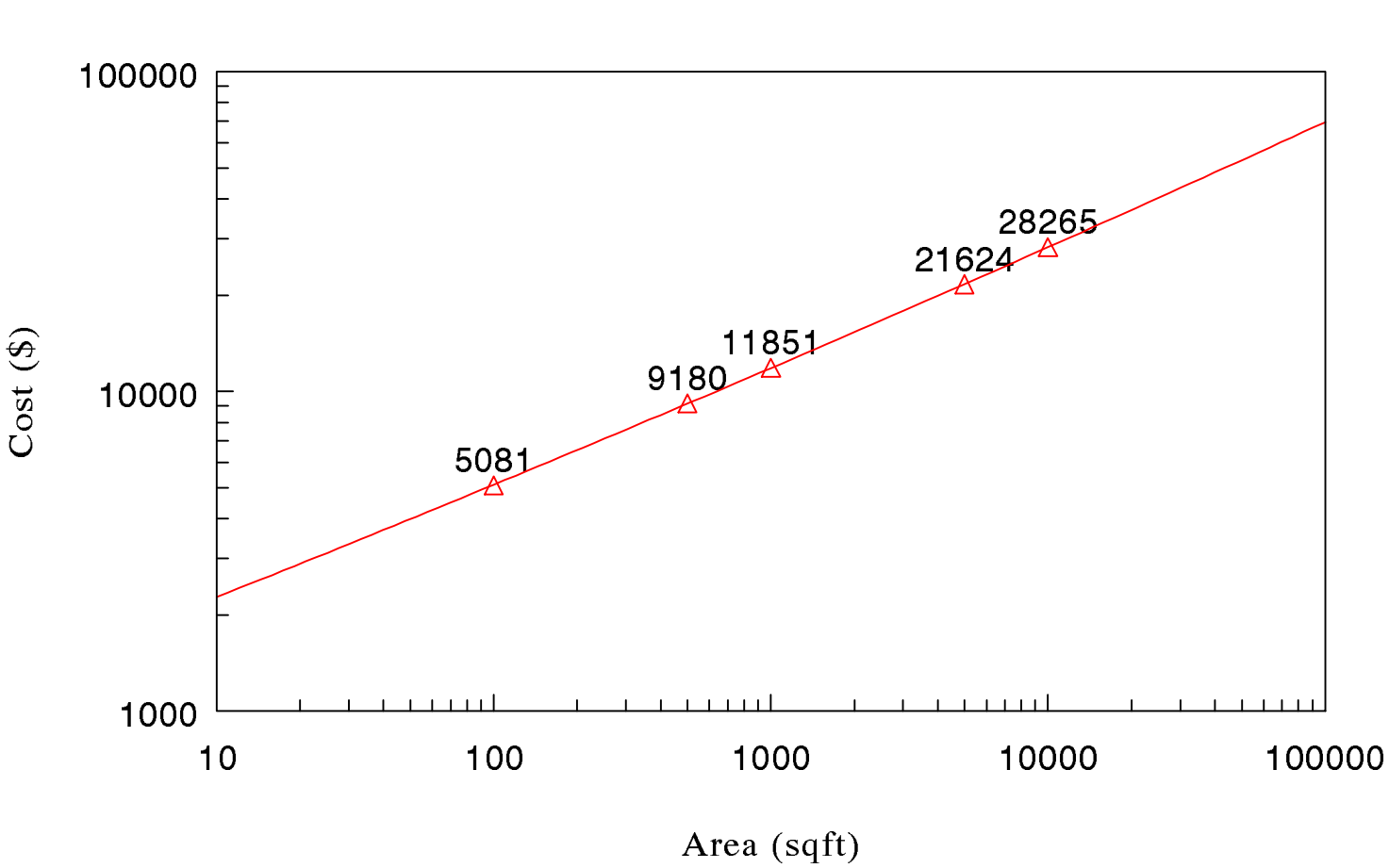


Figure 9-23
GAC Capital Cost Curve

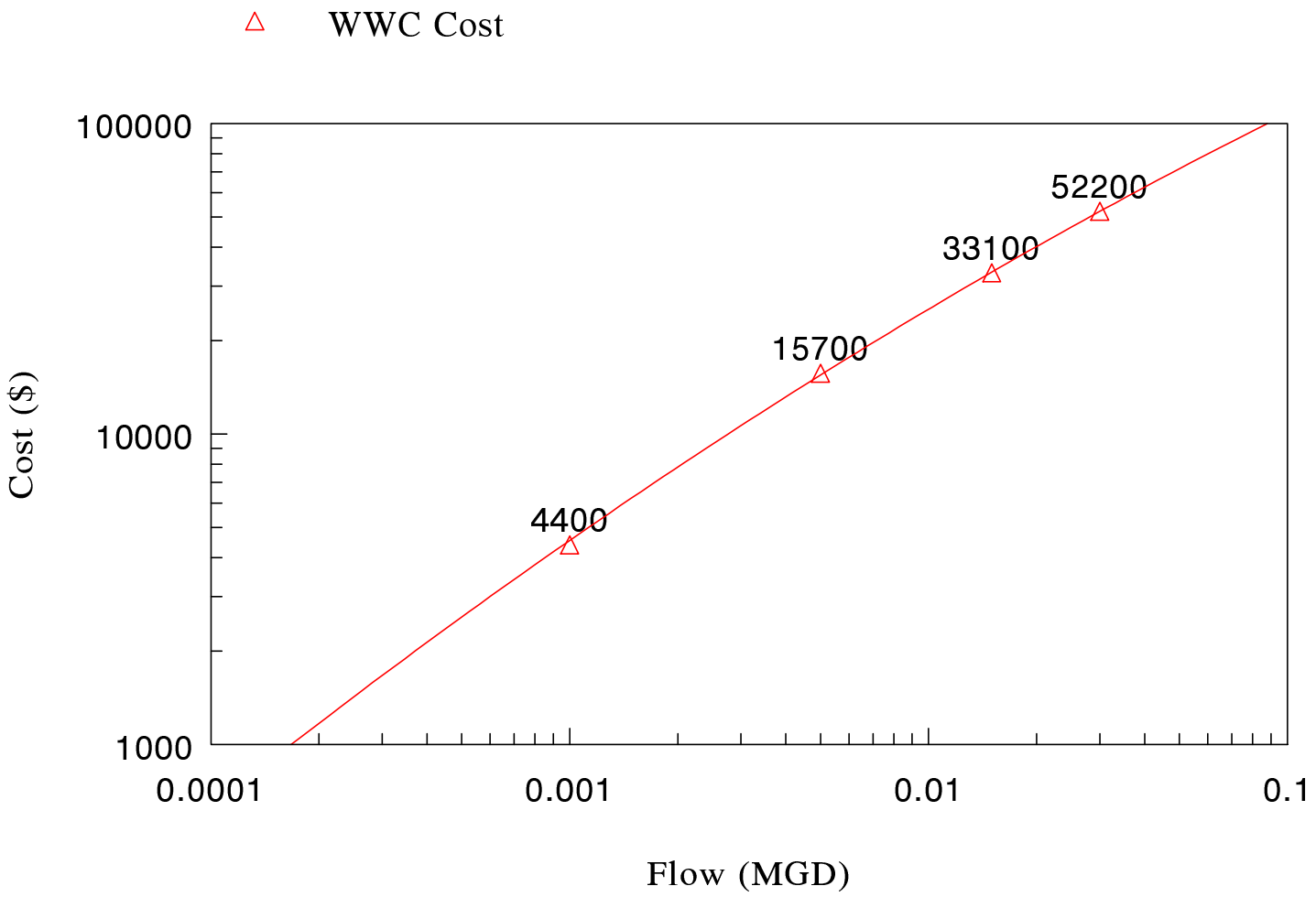


Figure 9-24
GAC O&M Cost Curve

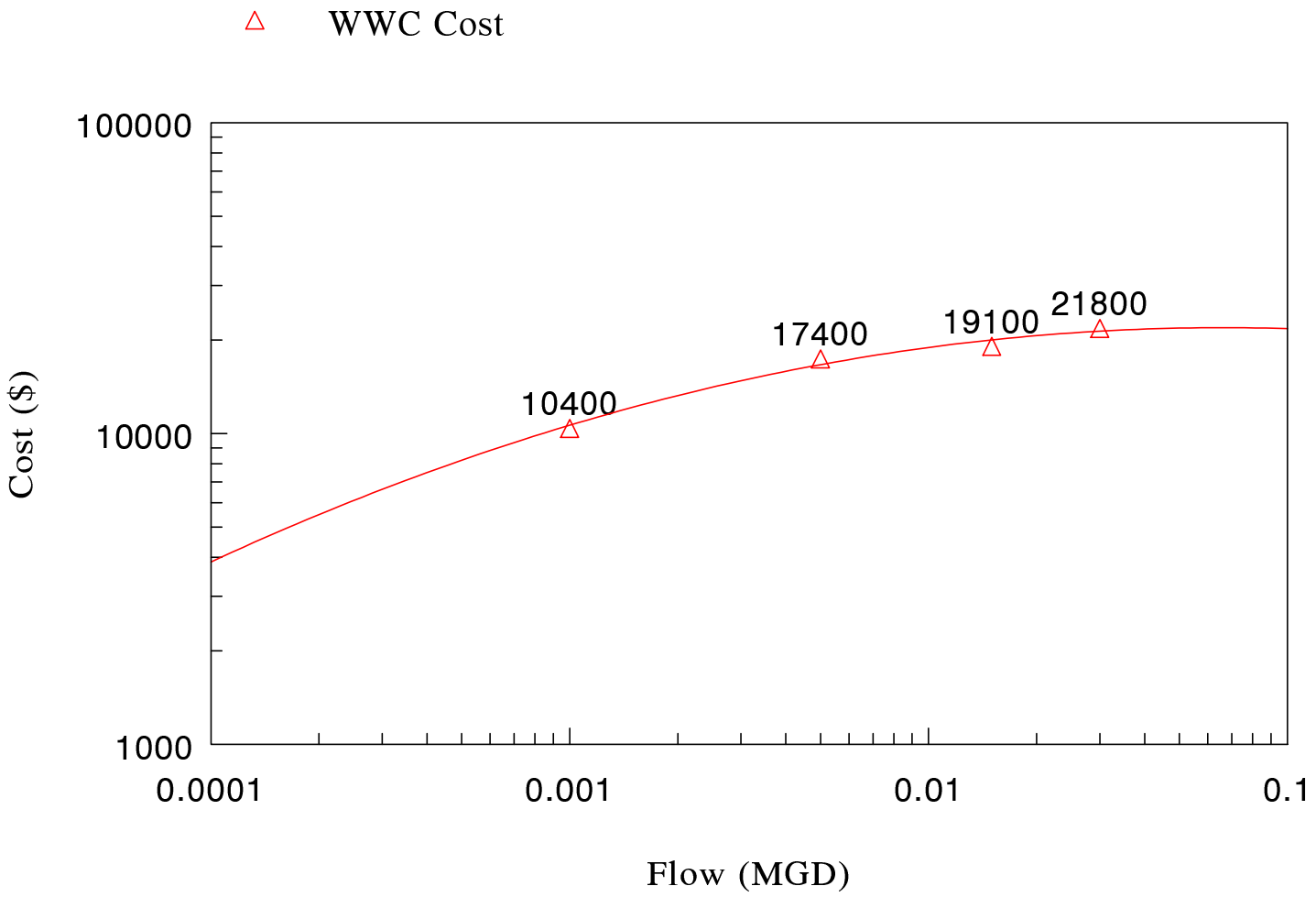


Figure 9-25
Brkpnt Chlorination Capital Cost Curve

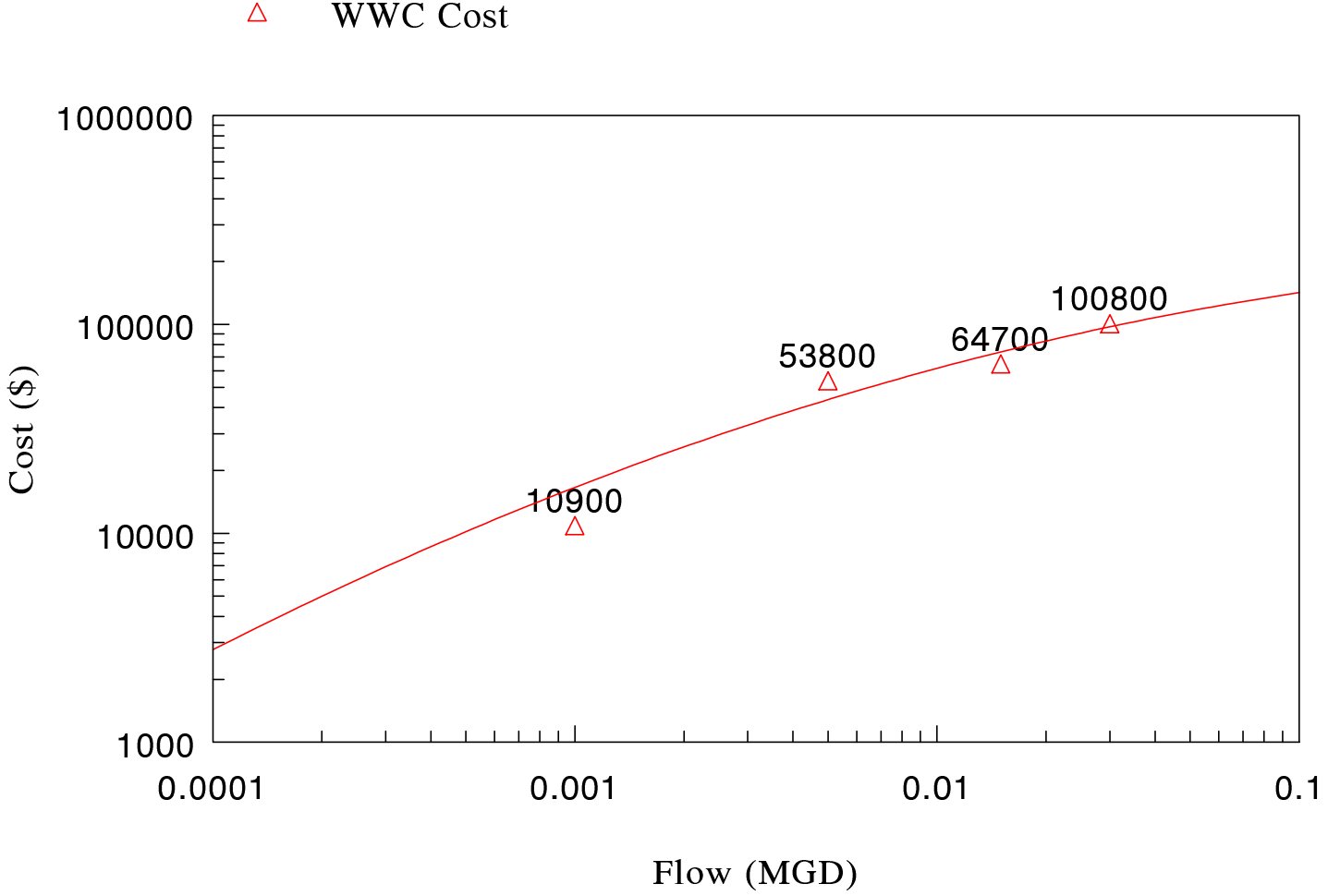
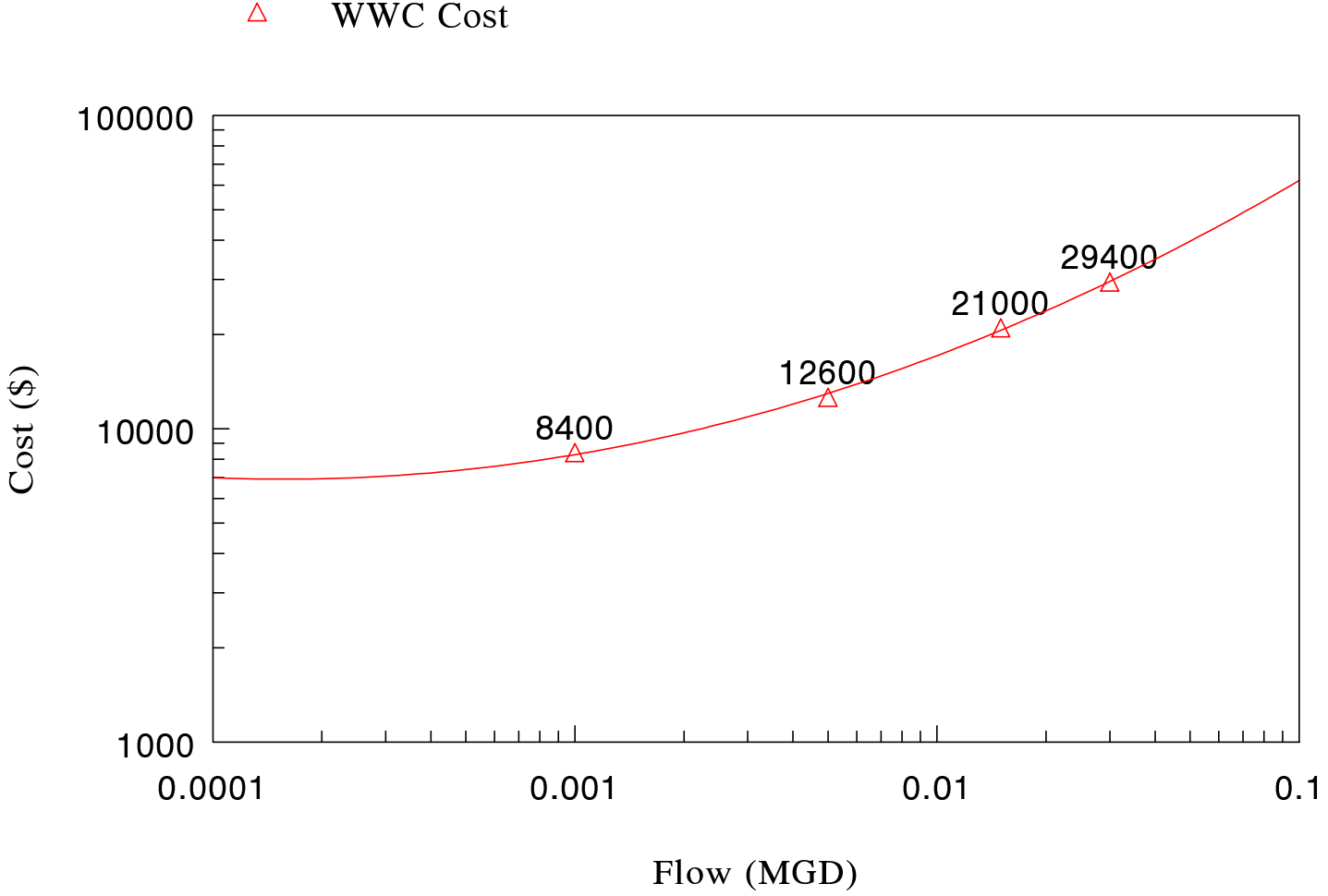


Figure 9-26
Breakpoint Chlorination O&M Cost Curve



10.0 NON-WATER QUALITY IMPACTS

The operation of wastewater treatment systems may have ancillary environmental effects by generating solid and hazardous residuals and air emissions, and by consuming energy in treatment.

The elimination or reduction of one form of pollution may create or aggravate other environmental problems. Therefore, Sections 304(b) and 306 of the Clean Water Act (CWA) require EPA to consider the non-water quality environmental impacts and energy requirements of effluent limitations guidelines and standards. In fulfillment of these requirements, EPA has considered the effect of promulgating the BPT, BCT, BAT, and NSPS regulations for the Landfills industry on the creation of additional air pollution, solid and hazardous waste, and energy consumption.

While it is difficult to balance environmental impacts across all media and energy use, the Agency determined that the impacts identified below do not outweigh the benefits associated with compliance with the limitations and standards.

10.1 Air Pollution

The primary source of air pollution from landfills results from the microbial breakdown of organic wastes from within the landfill. Landfills are known to be major sources of greenhouse gas emissions such as methane and carbon dioxide. These emissions are now regulated under the Clean Air Act (CAA) as a result of the municipal solid waste landfill Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources, promulgated by the EPA on March 12, 1996 (Federal Register: Volume 61, Number 49) and codified in 40 CFR 60 Subpart CC-Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills and Subpart WWW-Standards of Performance for Municipal Solid Waste Landfills. Many non-hazardous solid waste landfills are required to collect and combust the gases generated in the landfill. Wastewater collected from within the landfill contains organic compounds which include volatile organic compounds (VOC) and hazardous air pollutants (HAP). This

wastewater must be collected, treated and stored in units which are often open to the atmosphere and may result in the volatilization of certain compounds. Organic pollutants volatilize in reaching an equilibrium with the vapor phase above the wastewater. These volatile organic compounds are emitted to the ambient air surrounding the collection and treatment units. The magnitude of volatile organic compound emissions is dependent on factors such as the physical properties of the pollutants, the temperature of the wastewater, and the design of the individual collection and treatment units.

The landfill effluent guidelines limitations are based on the performance of an aerated biological system. Wastewater aeration may increase the volatilization of certain organic compounds, a potential environmental concern. However, indications are that the potential increase in air emissions due to the final landfill effluent guideline will be minimal. VOCs in hazardous waste landfill leachate are being steadily minimized due to the Resource Conservation and Recovery Act (RCRA) land disposal restriction rules, which typically require aggressive destructive treatment of organics in hazardous wastes before the waste can be landfilled (see 40 CFR 268.40 and 268.48).[1] VOC levels in historic landfill leachate (from both hazardous and non-hazardous waste landfills dating from the 1930s to the mid-1990s) are also at levels which are low enough as not to call into question EPA's determination to base these rules on the performance of aerated biological systems. Tables 6-9, 6-10, and 6-13 in Chapter 6 show the concentrations of VOCs found in landfill wastewater.

Furthermore, EPA's Office of Air and Radiation is currently evaluating the air emissions from wastewater generated at municipal solid waste landfills, and intends to take this rule into account in determining whether further controls under section 112 of the Clean Air Act (which requires technology-based standards for hazardous air pollutants emitted by major sources of emissions of those pollutants) are justified.

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[1] There are certain exceptions to these treatment requirements for hazardous wastewater which is disposed in surface impoundments. RCRA section 3005 (j) (11). However, if this wastewater contains VOCs above a designated concentration level, then the impoundments are subject to rules requiring control of the resulting air emissions. 40 CFR 264.1085 and 263.1086.

(Preliminary indications are that hazardous air pollutant emissions from aeration would be a minor fraction of those from other landfill emission sources such as landfill gas emissions.)

In addition, EPA is addressing emissions of volatile organic compounds from industrial wastewater through a Control Techniques Guideline (CTG) under Section 110 of the CAA. CAA amendments require that State implementation plans for certain ozone nonattainment areas be revised to require the implementation of reasonably available control technology (RACT) for control of volatile organic compound emissions from sources for which EPA has prepared CTGs. In September, 1992, EPA published a draft CTG document entitled "Control of Volatile Organic Compound Emissions from Industrial Wastewater." (EPA-453/0-93-056). This document addresses various industries, including the hazardous waste treatment, storage, and disposal facilities (TSDF) industry, and outlines volatile organic compound emissions expected from their wastewater treatment systems and methods for controlling them. For CTG guideline purposes, EPA has included Subtitle C and D landfills with leachate collection systems in the TSDF industry. EPA estimates that nearly all landfills affected by the Landfills effluent guideline will be subject to this CTG for volatile emissions from their wastewater treatment systems. It was estimated in the CTG draft document that 43 percent of the facilities in the TSDF industry are located in areas of ozone nonattainment. In 1994, the draft CTGs were revised to reflect changes that were made in the wastewater provisions of the Hazardous Organic National Emission Standards for Hazardous Air Pollutants promulgated by the EPA on April 22, 1994 (Federal Register: Volume 59, Number 19). EPA published these changes to the CTGs in a document entitled "Industrial Wastewater Alternative Control Technology".

10.2 Solid and Other Aqueous Waste

Several of the wastewater treatment technologies available to comply with the landfills regulation will generate solid and other aqueous waste. The costs for the disposal of these other waste residuals were included in the compliance cost estimates prepared for the regulatory options. Solid wastes generated by a number of the BPT, BCT, and BAT wastewater treatment technologies include sludge from clarifiers

associated with biological treatment and chemical precipitation systems and backwash waters from filtration systems.

In surveying both subcategories of this industry, EPA determined that it is common practice to dispose of the sludges generated by the on-site wastewater treatment systems directly back into the landfills. This practice eliminates the need for, and the costs associated with, off-site disposal. Analysis of sludge data collected as part of this study also indicates that sludges generated by wastewater treatment systems at landfills in the Subtitle D Non-Hazardous subcategory are non-hazardous, allowing them to be disposed of at the landfill sites from which they are generated.

Waste sludge generated by wastewater treatment facilities at landfills in the Subtitle C Hazardous subcategory may be a hazardous waste, depending upon factors such as the characteristics of the waste deposited in the landfill and the design and operation of the wastewater treatment system. If listed hazardous wastes, as per 40 CFR 261 Subpart D, are disposed of into the landfill, the resultant sludges from the treatment of landfill generated wastewater will be considered a hazardous waste. Based upon the "derived-from" rule found in 40 CFR 261.3(c)(2), the sludge will have the same RCRA waste code as the waste in the landfill for monofills. For hazardous waste landfills which dispose of more than one type of listed hazardous waste and generate a multi-source leachate, the sludge from treatment of the leachate will have the F039 RCRA waste code. Sludges from a treated leachate at a landfill which handles only characteristic wastes, as per 40 CFR 261 Subpart C, will need to be analyzed to determine whether it exhibits any of the characteristics of a hazardous waste as per 40 CFR 261 Subpart C. EPA has developed land disposal restrictions as found in 40 CFR 268. This regulation places restrictions on the land disposal of wastes and specifies treatment standards that must be met before wastes can be land disposed. For purposes of this regulation, EPA has assumed that dried sludges from facilities in the Subtitle C Hazardous subcategory will be returned to the on-site landfill for disposal. Similarly, EPA has assumed dried sludges from Subtitle D non-hazardous facilities will be returned to the on-site landfill for disposal.

Listed or characteristically hazardous waste sludges are to meet applicable treatment standards prior to disposal.

The increased amount of sludge created due to this regulation will be negligible in comparison to the daily volumes of waste processed and disposed in a typical landfill, whether non-hazardous or hazardous. As a result, the practice of on-site disposal has a minimal impact on landfill capacity. For example, based on national estimates, the Subtitle D Non-Hazardous subcategory processed approximately 5,300 million tons of waste in 1992. The BPT/BCT/BAT wastewater treatment options will generate approximately 0.0044 million tons per year of waste solids or only 8.3×10^{-5} percent of the volume of waste disposed into the landfill. For the Subtitle C Hazardous subcategory, the BPT/BCT/BAT option will generate approximately 194 tons per year of solids, as compared to the national estimate of 550 million tons of waste processed, which equates to 3.5×10^{-5} percent.

Filtration backwash waters are generally recycled to the beginning of the wastewater treatment system for reprocessing. This practice eliminates the generation of a waste stream needing disposal.

10.3 Energy Requirements

The operation of wastewater treatment equipment results in the consumption of energy. EPA estimates that the attainment of the BPT, BCT, and BAT standards will increase energy consumption by a very small increment over present industry use. The treatment technologies that are the basis for the limitations and standards are not energy-intensive, and the projected increase in energy consumption is primarily due to the incorporation of components such as power pumps, mixers, blowers, power lighting and controls, and heating devices. The associated energy costs are included in EPA's estimated operating costs for compliance with the guideline presented in Chapter 9. For example, the BPT/BCT/BAT Option 2 for the Subtitle D Non-Hazardous subcategory is estimated to consume 3,300 megawatt-hour per year (Mwhr/year). This is equivalent to approximately 1,800 barrels per year of No.2 fuel oil, as compared to the 1992 rate of consumption in the United States of 40.6 million barrels per year. The additional energy

demand imposed by this regulatory option will represent an insignificant increase in the production or importation of fuel oil. For the Subtitle C Hazardous subcategory, the regulatory option is estimated to consume 37.3 Mwhr/yr or an equivalent 21 barrels per year of No.2 fuel oil.